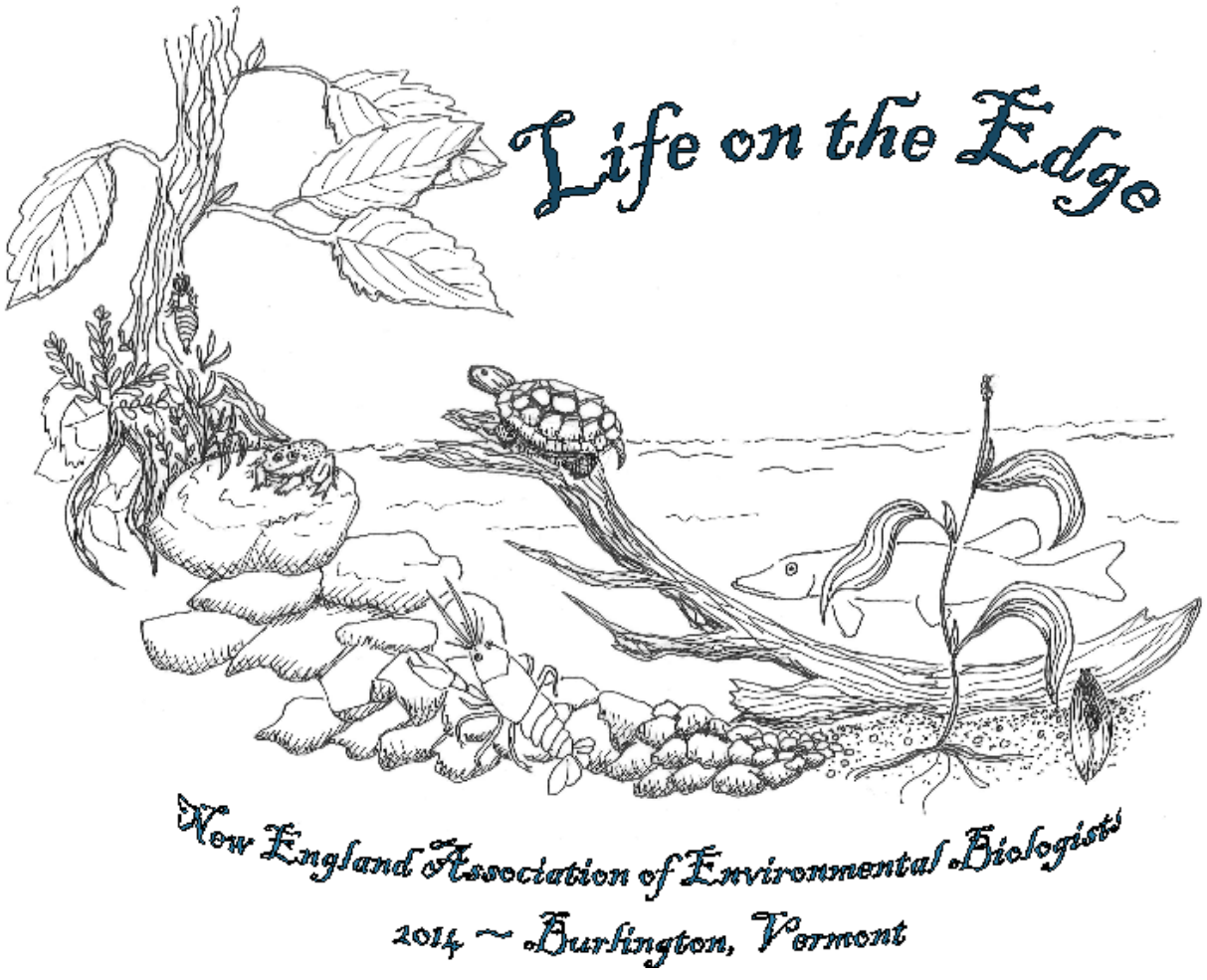
Conference Abstracts



26 - 28th March 2014 at the Hilton, Burlington, VT

3/25/14

Note: Abstracts are organized by session.

Session: Climate Change - A1
Wednesday 3/26/14 1:00 – 3:00

A Vulnerability Analysis and Adaptation Framework for Natural Resources in Vermont
Ben Jessup and Jen Stamp, Tetra Tech, Inc.

The Vermont Agency of Natural Resources has assembled information necessary to create a climate change adaptation framework, including results from a series of interactive workshops. The intent is to coordinate efforts within four divisions of the agency, Wildlife, Fisheries, Forestry, and Watershed Management. Tetra Tech assembled climate change information, facilitated the workshops, and wrote guidelines for further development of the framework. The strategic adaptation framework is based on our understanding of climate change exposures (climatic changes expected to affect resources), our expectations of natural resource vulnerability to those exposures, and our perceptions of cooperative opportunities for addressing the vulnerabilities, including ongoing and proposed actions that can be taken to mitigate or prepare for the expected changes. Exposures that we described included increases in temperature and precipitation. Increases have been documented in the last 50 years and those trends are expected to continue. Hydrology and extreme weather events are likely to be variable or increase, though they are harder to predict. Vulnerability assessments were conducted to identify which habitats or species are likely to be most strongly affected by projected climatic changes and to understand why these resources are likely to be vulnerable. The habitat assessments focused on four major habitat groups: upland forests, wetlands, rivers, and lakes. Vulnerabilities were estimated using examples from the northeastern region and expert consensus during one workshop. Climate change adaptation actions were also explored through examples in existing state adaptation plans as well as expert panel discussions in a second workshop. By cataloguing existing and proposed adaptation actions, it became evident that many of the actions are strongly aligned with actions needed and already initiated to reduce various types of pollution in Vermont's watersheds. This alignment leverages the ecological resiliency that is built into the environmentally intact systems we are already striving to restore and protect.

Research on Adaptation to Climate Change (RACC): A Coupled Human-Natural Systems Approach
Christopher Koliba, Gund Institute

In this presentation researchers from the University of Vermont and Vermont EPSCoR provide a broad overview of the RACC project, including a brief discussion of the ongoing data collection and watershed modeling, the modeling of human decision-making as it pertains to land use, best management adoption, and policy implementation, and the integration of these models and data collection efforts into an integrated assessment model. Also discussed is RACC's ongoing efforts to engage stakeholders through mediated modeling workshops and web-based Delphi survey projects. Implications for practice are drawn.

Quantifying Uncertainty in Modeling the Impacts of Climate Change on Water Quality in Freshwater Lakes: A Bayesian Network Model of Missisquoi Bay
Asim Zia, Andrew Schroth, Yaoyang Xu and Peter Isles, UVM

Anthropogenic climate change could induce abrupt alternate stable states in the Lake Champlain segments from more frequent and more intense flooding events in Lake Champlain Basin as well as reduced ice cover internally in the lake system. Concern within the Lake Champlain system arises from the continued eutrophication of shallow bays such as Missisquoi Bay. The severity of algal blooms are subject to a variety of influences, ranging from N and P fluxes in the lake segments, water depth, formation and evolution of zooplankton species, and vertical and horizontal profiles of temperature gradients. Understanding the impacts of anthropogenic climate change on water quality, such as formation and persistence of harmful algal blooms (HABs), requires quantification of uncertainty that is introduced in assuming future trajectories of N and P fluxes as well as water and atmospheric temperature gradients. In this paper, we present a novel Bayesian Network Model (BNM) to predict the bi-weekly probability of HABs in the Missisquoi Bay segment of Lake Champlain under three different IPCC climate change scenarios. The LCBP and USGS monitoring data from 1992 to 2010 are used to train the BNM, while 2011-2013 monitoring data is used to test the predictive power of the BNM. This BNM reproduces the observed uncertainty in predicting bi-weekly N to P ratios and the consequent likelihoods of HABs within the 90th percentile. The calibrated version of the BNM is used to modify the N and P fluxes under different land-use scenarios as well as temperature gradient scenarios for generating probability density functions of N to P ratios and the likelihood of HABs. Implications of this quantified uncertainty for designing TMDL loads are discussed. Finally, a generalization approach of this BNM to other lake segments of Lake Champlain as well as other fresh water lakes is provided.

The Northeast Regional Monitoring Network for freshwater wadeable streams
Jen Stamp, Tetra Tech Inc., Margaret Passmore, US EPA, Anna Hamilton, Tetra Tech Inc., Britta Bierwagen, US EPA, Jonathan Witt, US EPA

The United States Environmental Protection Agency (US EPA) is working with its regional offices, states, tribes and other entities in the Northeast, Mid-Atlantic and Southeast regions to establish Regional Monitoring Networks (RMNs) at which biological, thermal and hydrologic data will be collected from freshwater wadeable stream sites. The goal is to integrate the RMNs into existing programs, and to support existing programs, rather than starting something from scratch. By coordinating these efforts at a regional level, resources can be pooled and efficiencies can be increased. During this talk, we will provide a status update on activities that are taking place in the Northeast RMN and will discuss results from a classification analysis and climate change vulnerability assessment for the eastern USA. In addition, we will discuss a recent draft EPA report on the process that was followed when setting up the RMNs, site selection, expectations and guidelines for data collection and quality assurance procedures, the rationale for collecting these data and how these data will be shared, used and analyzed.

Session: Stream Temperature- A2
Wednesday 3/26/14 3:30 – 5:00

NorEaST - A stream temperature inventory mapper and data portal for New England, Mid Atlantic and Great Lakes states streams
Dave Armstrong, USGS
The USGS Northeast Climate Science Center is in the process of developing the NorEaST Stream Temperature Inventory Mapper and Web Portal to provide a means for coordinating and connecting

stream temperature sampling efforts and data across multiple agencies in New England, Mid-Atlantic, and Great Lakes States. The NorEaST project is compiling metadata about existing stream temperature monitoring locations and networks in the region. The NorEaST Mapper will provide a location where data stewards can store and manage stream temperature data. For agencies that maintain temperature databases, the NorEaST Mapper can connect to these databases using webservices. The NorEaST Mapper provides a means for the public to view locations and metadata for current and historic stream temperature monitoring sites. To date, the NorEaST Mapper displays over 8000 locations where continuous stream temperature data have been collected from 45 different organizations. The NorEaST database provides a standard data protocol for agencies with file-based systems. Data stewards can request to become users and can load, manage, and retrieve data associated with their agencies. The NorEaST Mapper and Web Portal provides a means to view site information, identify monitoring gaps, generate data standards, manage data, use data for regional analyses and comparisons, or to develop stream temperature models. This information will be useful to plan for and assess the effects of climate change on streams throughout the region.

Summer Thermal Thresholds of Fish Community Transitions in Connecticut Streams
Chris Bellucci, Mike Beauchene, Mary Becker, CTDEEP

Thermal tolerances have been studied for individual fish species but few have investigated how stream fish assemblages respond along a temperature gradient and which thermal ranges act as a threshold, triggering discernible community change. The purpose of this study was to define summer temperature thresholds of fish community transitions in Connecticut streams. Threshold Indicator Taxa Analysis suggested that the coldwater class had a June-August mean water temperature 21.70°C. Significant indicator species of coldwater streams were Slimy Sculpin (*Cottus cognatus*) and Brook Trout (*Salvelinus fontinalis*). Significant indicator species of warmwater streams were Cutlip Minnow (*Exoglossum maxillingua*), Smallmouth Bass (*Micropterus dolomieu*), Rock Bass (*Ambloplites rupestris*), Brown Bullhead (*Ameiurus nebulosus*), and Yellow Bullhead (*Ameiurus natalis*). The narrow 3.41°C temperature range between the coldwater and warmwater thresholds was designated as a coolwater transition zone, with potential for the presence of both coldwater and warmwater species and lack of species uniquely associated with this thermal range. Our approach based on a robust set of water temperature and fish community data should be applicable to other temperate regions and it will be useful for informing development of thermal criteria, application of multi-metric indices, and planning for anticipated effects of climate change.

Incorporating retention time to refine models predicting thermal regimes of stream networks across New England
Naomi Detenbeck, USEPA Atlantic Ecology Division, Alisa Morrison, US EPA AED Student Services Contractor, Ralph Abele, US EPA Region 1

Thermal regimes are a critical factor in models predicting effects of watershed management activities on fish habitat suitability. We have assembled a database of lotic temperature time series across New England (> 7000 station-year combinations) from state and Federal data sources. Using principal component analysis, we reduced 78 thermal metrics from the ThermoStat software package to four independent fish habitat predictor variables: July or August median temperature, Julian day of maximum daily temperature, mean daily temperature range, and maximum daily rate of temperature change. We are creating spatial statistical models for stream temperature regime metrics, using an approach developed by the U.S. Forest Service. Median July and August stream temperatures are best predicted by a combination of median monthly air temperatures, main channel slope, solar radiation

(corrected for topographic and riparian shading), coarse surficial deposits, and watershed storage (August only). Predictors for daily July or August stream temperature range and growing season maximum temperature also include corresponding air metrics, watershed percent imperviousness and mean discharge (daily ranges only). With one exception, only maximum daily rate of change (ROC) in air temperature was retained in predictive models for stream ROC values. Best models based on Akaike Information Criteria values included spatial covariance terms using both proximity along the stream network (upstream and/or downstream) and, in some cases, Euclidean distance. Performance of models constructed using travel (retention) time to estimate spatial covariance are being compared with those based on instream distance. Predicted thermal regime variables will be used as input to models that predict relative abundance of selected fish species, chosen based on their sensitivity to urban development. Predicted versus observed fish community composition will be compared for watersheds in which stormwater best management practices have been applied.

Session: Lake Champlain I – B1
Wednesday 3/26/14 1:00 – 3:00

Quantifying the effects of cyanobacterial buoyancy regulation on lake metabolism and benthic oxygen dynamics using high-frequency data
Peter Isles, UVM

Bloom-forming cyanobacteria impair water quality and threaten human health in water bodies throughout New England and beyond, and their prevalence is likely to increase with increasing global temperatures. One of the drivers of cyanobacterial blooms in many shallow lakes is the accessibility of sediment stores of phosphorus, which in turn depends on the levels of oxygen in the bottom waters and the upper sediment layers. Because the oxygen dynamics in fully mixed shallow lakes are largely governed by phytoplankton photosynthesis and respiration, particularly in eutrophic systems, feedbacks may result which contribute to the maintenance of bloom conditions. The strength of these feedbacks may be magnified by diel vertical migration in cyanobacteria. Here we investigate the interactions between lake metabolism and cyanobacterial buoyancy regulation using high-temporal-resolution data from a monitoring buoy moored in Missisquoi bay, Lake Champlain. Our analyses highlight seasonal trends in NEP, the important role that buoyancy regulation plays in overcoming light limitation and increasing primary production, the roles of physical drivers (wind and irradiance) in mediating these processes, and the interactions between these processes and seasonal nutrient dynamics.

Agricultural Practice Monitoring and Evaluation on Lake Champlain Basin Farms
Julie Moore and Dave Braun, Stone Environmental

Agriculture has been identified as a major contributor of phosphorus (P) to Lake Champlain. Vermont farmers are facing increasing pressure to reduce P losses from their operations. Although federal and state programs, as well as landowners, have made unprecedented investments implementing agricultural best management practices (BMPs), these efforts have not yet yielded desired water quality results. There is an urgent need to evaluate and document the effectiveness of BMPs in the Lake Champlain Basin so that the most effective practices may be emphasized and reasonable assurance may be provided that plans to achieve P TMDL targets will be successful. In 2012, the Vermont Agency of Agriculture, Food, and Markets (VAAFM), in cooperation with USDA-NRCS, initiated an edge-of-field monitoring study to evaluate several innovative BMPs currently promoted by VAAFM and USDA. The study design and procedures meet the criteria of the NRCS Code 799 practice standard in force at the time the study began. Stone Environmental was selected to conduct the study. A paired watershed

study design is being used to test the effects of four different BMPs on event discharge and pollutant concentration and export in surface runoff from study fields. The study duration will be 3-5 years. Six farms in the Lake Champlain Basin, from Franklin south to Pawlet, are participating. Farm operators are voluntarily participating by implementing the BMPs, providing access to their fields, and maintaining data on their management activities. Practices being evaluated include: soil aeration on hayland prior to manure applications, cover cropping on silage corn, reduced tillage and manure injection on cornland, and a water and sediment control basin treating runoff from a cornfield. Discharge, rainfall, and air temperature are being measured continuously. Event composite samples are collected using a flow-paced autosampler. The telemetry and telecommand capabilities of the monitoring systems enable efficient management of sampling teams, instruments, and data. Monitoring design, instrumentation, and operation will be discussed as part of the presentation. Summaries of data collected from events monitored in 2012 and 2013 will be presented.

Measuring and Modeling the Effects of Lakeshore Development on Littoral Habitat and Biota in Malletts Bay, Vermont

Evan Fitzgerald and Joe Bartlett Fitzgerald Environmental, and Britt Hasleton, Vermont Land Trust

An increasing body of literature from the U.S. and across the globe has linked shoreline development with reduced habitat quality in the littoral zones of lakes and ponds. In the Lake Champlain Basin and throughout the region, there is rising concern over the degradation of lake littoral zones resulting from shoreline development. While other New England states have adopted shoreline protection regulations, Vermont and New York have yet to adopt statewide regulations restricting the nature of shoreline development above mean high water. In response to ongoing littoral zone degradation, the VTDEC has made substantial efforts to research this topic. Various VTDEC studies on inland lakes in Vermont and Maine highlight the sensitivity of the littoral zone to adjacent development, and the importance of buffer regulations in mitigating impacts. Prior to this study, limited research had examined the impacts of lakeshore development on littoral habitats of Lake Champlain. Given the larger scale of physical and hydrologic process in Lake Champlain relative to smaller inland lakes, a key question spurring this research was whether the littoral zone response in Lake Champlain would differ from the inland lakes. Our study was designed to utilize a relatively small set of representative sample points on the lake's shoreline to model conditions in the greater lake. We chose Malletts Bay in Vermont as our principal study area due to its heterogeneity in both natural gradients (e.g., substrate type and wind exposure) and shoreline land cover. Our intensive study included detailed land cover mapping over the entire Malletts Bay shoreline, littoral habitat sampling covering a total of 90 sites for riparian, structural, and vegetative data, macroinvertebrate sampling at 33 sites, and fish sampling at 35 sites. We also studied wind/wave exposure and littoral slope as natural gradients that may influence littoral habitat condition independent of shoreline development. Overall, our findings indicate both broad patterns in the response of littoral habitat quality to shoreline development (e.g., reduced tree cover) regardless of natural setting, as well as littoral habitat responses that are unique to site-specific natural settings and gradients (e.g., substrate type, littoral slope, etc.). Despite the fact that changes to some littoral habitat characteristics vary depending on the natural setting, our study strongly indicates that high-intensity shoreline development significantly alters the natural character and condition of each of the substrate types we studied.

Northeast U.S. Regional Lake Shoreland Assessment Project
Dan Homeier, Kellie Merrell, and Leslie Matthews, VTDEC

In 2012 the National Lakes Assessment (NLA) sampled 904 lakes throughout the conterminous United States. The survey collected a range of data in an effort to assess ecological, water quality, and recreational indicators. The relationship between these data and remotely sensed land cover has not yet been explored. Vermont Department of Conservation (DEC), in conjunction with NEIWPCC and EPA Region 1 partner states, is exploring two remote sensing methods, a GIS Land Cover Classification Model and a Visual Assessment Tool, and their ability to evaluate shoreland condition along 2012 NLA sampled lakes in the North Appalachians (NAP) ecoregion. The GIS Land Cover Classification Model utilizes the image analysis and classification tools within ArcMap 10.2 to create, using a pixel based method, a land use/land cover (LULC) layer for HUC12 watersheds containing 2012 NLA sampled lakes. The Visual Assessment Tool utilizes visual inspection and assessment of aerial imagery to create a georeferenced survey of NLA observation stations. Both methods utilize 1 meter, 4-band National Agricultural Imagery Program (NAIP) imagery collected between 2012 and 2013. The focus of this presentation is our methodology, to-date results, and pending conclusions.

Session: Lake Champlain 2- B2
Wednesday 3/26/14 3:30 – 5:00

Where Rivers Meet Soil - Contribution of Riparian Soils to Phosphorus Loading in Northern Vermont
Caroline Alves, Kristen Underwood and Don S. Ross, University of Vermont

Eroding streambanks, avulsions cutting across floodplains, and mass failures deliver sediment directly into receiving waters. Suspended sediment, a problem in itself, is also a delivery mechanism for phosphorus loading, with resulting negative water quality impacts. Soils are more difficult to sample than water; as a result the soils database is less robust than water quality measurements in the Lake Champlain region. The Natural Resource Conservation Service (NRCS) has partnered with the University of Vermont and watershed groups to conduct a broad-scale inventory of soils along 8 river corridors in Northern Vermont that drain to Lake Champlain. The data generated from this sampling project has been used to inform modeling efforts to quantify P loading from stream bank erosion using the Agricultural Research Service's BSTEM model. The complexity and spatial variability of floodplain soils makes it difficult to delineate soil map-units that capture this diversity at commonly used mapping scales. In the dynamic alluvial environment, textures can range from large gravel to microscopic clay sized particles within short distances. Alluvial deposits bury organic-rich topsoil complicating sampling protocols and confounding soil horizon descriptions. Few of the 60 soil pedons sampled from floodplains in the course of this project have matched the mapped soil series. Floodplain soils have many unique management issues that are not completely addressed by the existing suite of conservation planning practices. The standard measures of soil erodibility may not fully capture the susceptibility of floodplain soils to erosion and export. Indeed, the majority of these soils are rated "non-highly erodible" given their flat topography. Developing effective strategies to reduce soil loss on agricultural land demands that more attention be paid to the fluvial environment. In their paths from headwaters to lowlands, Lake Champlain rivers traverse through soil materials of various origins, from glacial tills in the Green Mountains to glaciofluvial deposits along valley margins, to ancient lake and marine sediments of the Champlain Valley. Water quality sampling campaigns along rivers should include a focus on the influence of differing parent material on water chemistry and turbidity. There is much to be gained by greater information exchange between water quality professionals and soil scientists.

Mapping the 'subaqueous soils' in Missisquoi Bay, Lake Champlain
Thomas Villars

The Vermont Subaqueous Soils Pilot Project in Missisquoi Bay of Lake Champlain tested the feasibility and utility of characterizing and mapping subaqueous soils in Vermont, for use as a tool for improving water quality. The purpose of the project was to create subaqueous soil maps for Missisquoi Bay (Vermont, US portion) and develop supporting data and interpretations in order to test the value of this information in addressing resource concerns in Vermont's lakes and ponds. A "subaqueous soil"□ is a soil that's formed in shallow water from lacustrine, deltaic, or marine sediments. They can be comprised of both mineral and organic materials. Subaqueous soils support the growth of rooted native and invasive aquatic vegetation, and their spatial variability can influence the spread of invasive species. Ground-penetrating radar (GPR) was effective in creating the bathymetric map needed for the project. GPR also provided radar images of subsurface sediments. Using the radar imagery and their locations in the bays, targeted sampling of the underlying sediment led to the identification of several distinct soil parent materials and subaqueous soil types. The 0.5-meter contour bathymetric map shows significant areas of shallow near-shore flats, deltaic areas, a shoal, steeply sloping materials below rocky cliffs along the eastern shoreline, and the extent of the deeper bay bottom. Different subaqueous soils are in these different subaqueous landforms. Several types of subaqueous soil parent materials have been identified, including lacustrine silts, stratified deltaic sand, gravel and loamy material, organic deposits overlying mineral strata, and underwater rock outcrops. A rocky shoal in the bay separates the deeper lacustrine silts from the other parent materials. Soil cores have supported the recognition of at least 4 different types of subaqueous soils in Missisquoi Bay. The soils have been classified using the USDA system of Soil Taxonomy. Lab datasets, with textural analysis, mineral characterization, and nutrient analysis, have been created for the different subaqueous soils. They range in texture from muck to gravelly sand to silty clay loam, and have varying levels of organic matter, phosphorus, and other nutrients. The study and mapping of the subaqueous soils in Missisquoi Bay can provide new information to resource managers. The information about the characteristics and spatial extent of these soils fill an important gap in our understanding of the Bay, and of the factors that are influencing water quality.

A Conservation Partnership to Restore Ecosystem Services along the New Haven River
Kristen Underwood and Steven Libby, Vermont River Conservancy

In Bristol, Vermont, a ten-year collaboration between landowners; town government; regional, state and federal agencies; and non-profit groups has culminated in the protection of 54 acres of intact and prior-converted floodplain forest with 3,800 feet of frontage along the New Haven River. The project site is located along a highly dynamic and depositional reach of the river, characterized by braided flows and channel migration. Permanent conservation of the riparian corridor on these lands has ensured that the river is unconstrained by infrastructure and has room to move, deposit sediment, and attenuate flows. This project supports a return to naturalized channel and floodplain functions, following a history of intensive channel management. The river is regaining access to its floodplain. Stormwater flows will be attenuated and sediment production to downstream reaches will be reduced over the long term, leading to reduced flood hazards, and improved water quality and aquatic habitats. This presentation will trace the project history with a focus on development of the private / public partnerships and diverse array of technical programs and funding sources that enabled successful project implementation.

Session: Flow-Runoff- C1
Wednesday 3/26/14 1:00 – 3:00

Using storm-watersheds to detect sources of pollution and prioritize land conservation areas at the local scale
Christina Chiappetta

Many planning and land use decisions in New York State are controlled at the local (town or municipal) level, restricting the implementation of conservation practices to a local scale. This is not necessarily the best scale for conservation management (1). Watershed boundaries represent a more ecologically sound conservation unit, reflecting the natural scale of ecosystem processes rather than artificial political boundaries that blur the processes operating in separate ecological units. This problem is even more extreme in an urbanized system where watershed boundaries are uncertain. Municipalities add stormwater infrastructure (including structures which capture, convey, and discharge flow) as-needed, often without regard for the natural drainage patterns dictated by topography. Storm-watersheds occur when stormwater infrastructure perforates municipal and watershed boundaries, creating man-made, "novel watersheds." Ecological impacts of stormwater runoff are difficult to assess. Minimum Control Measure 3 (MCM3), of the SPDES Municipal Separate Storm Sewer Systems (MS4) Permit, addresses illicit discharge detection and elimination of stormwater pollution, but it is difficult to apply at a watershed scale (2, 3). The objective of this study is to use a multi-criteria decision analysis to prioritize land parcels for conservation and restoration, based upon principles of biodiversity conservation, in an MS4 watershed. Using a GIS, a multi-criteria index which evaluates the land's conservation value was developed. The Kromma Kill storm-watershed in Menands, NY was selected as a case study to apply the model. Both high and low priority conservation areas were selected to explore land use decisions in order to promote biodiversity. Using storm-watersheds to detect sources of pollution and high priority conservation areas will be a more effective method for assessing and implementing municipal conservation priorities.

Development of a Flow Restoration Plan for Centennial Brook, Vermont
Nigel Pickering and Emily Schelley

For streams listed as impaired on Vermont's 303(d) list for sediment, nutrient, and bacterial issues, flow Total Maximum Daily Loads (TMDLs) are a strategy used by Vermont Department of Environmental Conservation (VDEC) to ameliorate the negative effects of excessive runoff from impervious areas. A flow TMDL requires the restoration of high and low flow targets and the development of an implementation plan commonly known as a flow restoration plan (FRP). This presentation describes Vermont's flow TMDL process and the development of the technical information to support a FRP for Centennial Brook, a cold-water fishery with a 1.4 square mile watershed near Burlington. The TMDL for this watershed suggests an increase in low flows by 23% and requires a decrease in high flows by 63%. The final Municipal Separate Storm Sewer System (MS4) permit requires the four regulated entities of Burlington, South Burlington, University of Vermont, and the Vermont Agency of Transportation to develop and implement a FRP to meet the flow targets of the TMDL. In a collaborative effort with the Chittenden County Regional Planning Commission, the four regulated MS4 communities, and VDEC, the project team used desktop analysis and follow-up field work to identify and conceptually design stormwater management control measures throughout the watershed. The VTBMPDSS stormwater model was used to evaluate if the cumulative effects of the proposed stormwater controls meet the TMDL flow restoration targets at the outlet of the watershed. Numerous alternative scenarios were modeled and evaluated to determine a scenario that meets the TMDL requirements and is also

acceptable to the MS4 partners. The original TMDL target of 63% was found to have an excessive allowance for future growth and was adjusted to 51.5%. Although green infrastructure (GI) was a preferred option for stormwater retrofits, there were not enough GI opportunities to make a substantial difference to the overall watershed streamflow. In order to meet the 51.5% reduction in high flows, we found that detention in open basins had to be extended beyond the 12-hour requirement for a cold-water fishery. The final scenario favored the use of infiltration systems and detention basins. Approximate installation costs were also provided for the final scenario.

Effect of Road Salt Load on Cation and Anion Export from Forested Watersheds in the Adirondack Park
Dan Kelting and *Corey Laxson, Paul Smith's College*

Because of low purchase price and ready accessibility, road salt (sodium chloride) is the most commonly used de-icing chemical, and its use on highways has increased steadily since the 1940s. New York State is the largest user of road salt in North America, and the amount of road salt used in the Adirondack Park greatly exceeds the inputs of other regionally important pollutants like acid rain. Road salt has the potential for significant negative effects on forest and aquatic ecosystems that may be on par with or greater than those reported for other regional pollutants. The objectives of this project are to understand the effects of road salt application rates (tons of salt per mile of road) on soil fertility and water quality and to develop practical information to aid agencies and municipalities in selecting management practices that reduce the impacts of road salt on forest and water resources. Stream discharge and chemical export are being monitored intensively on a network of 15 streams in the Adirondack Park representing a broad range of road salt application rates. To provide high-quality and reliable data in a cost-effective manner our approach is to measure specific conductance and stream stage at 30 minute intervals with remote loggers. Water samples are collected periodically for chemical analysis and calibration curves are developed from these data to estimate stream chemistry from conductivity. Export is determined by multiplying estimated ion concentrations by stream discharge, which is derived from stage-discharge calibration curves also developed over time through periodic stream velocity measurements. The data will be used to develop relationships between road salt application rate and water quality response that managers can then use to help choose and justify alternative road salt application rates to meet water quality objectives. Though the focal region is the Adirondacks, because road salt is widely applied across the Northern Forest region and Adirondack soils and geology are similar to others in the region, the results will be widely applicable. This project is sponsored by the Lake Champlain Basin Program, Northeastern States Research Cooperative, and ADKAction.org.

Estimating the spatial extent of road runoff impacts on terrestrial and aquatic environments in the Adirondack Park
Sean Regalado and Dan Kelting, Paul Smith's College

Delineating overland flow down-slope of roads can provide fundamental spatial information to resource management in forested landscapes. This paper quantifies the spatial extent of road runoff impacts in the 2.4 million hectare Adirondack Park by constructing a park-wide hydrologic terrain model, derived from 10m USGS DEMs, that (a) quantifies the total area of terrestrial land impacted by runoff, (b) identifies the lakes and ponds intersected by runoff and calculates their total surface area, and (c) quantifies the total length of rivers and streams impacted by runoff. This study delineates hydrologic flow originating from three categories of roads: state and federal (SF), county, state, and federal (CSF), and local, county, state and federal (LCSF) roads using TauDEM 5.1.1 Hydrologic Terrain Analysis and ArcMap 10.1 software. This study found that as much as 10% of total land area, 80% of total surface

water area, and 50% of rivers and stream length may be impacted by road runoff in the Adirondack Park. The spatial information produced by this study is also useful for focusing monitoring, research, and management efforts aimed at understanding and reducing the impacts of road runoff on terrestrial and aquatic environments.

Session: Bioassessment- C2
Wednesday 3/26/14 3:30 – 5:00

Comparison of assessment outcomes between the New England non-wadeable rivers fish assemblage assessment and the national rivers and streams assessment 2008-9
Chris Yoder

The National Rivers and Streams Assessment (NRSA) included the sampling of fish assemblages in the large rivers of New England in 2008-9. This survey overlapped with our New England Large Rivers (NELR) REMAP fish assemblage assessment that we have reported on previously. NELR REMAP sampling sites were positioned to overlap with THE 64 New England NRSA sites in order to provide a comparison of the two different sampling methodologies. Each survey employed the same boat and raft mounted electrofishing gear. However, the sampling site layout and the execution of the sampling were substantially different between the NRSA and NELR REMAP methods. The NELR REMAP assessment was accomplished across all of New England using the REMAP probabilistic design and comparing that outcome to a more spatially dense intensive pollution survey design that was accomplished on most of the primary mainstem rivers. We previously reported that the intensive pollution survey design captured the highest quality sites as measured by the Maine Rivers IBI that were not revealed by the REMAP probabilistic design. This prompted a question about whether there are similar differences between the Maine IBI and the NRSA fish MMI and therefore the assessments produced by each survey. Several comparisons were made possible by the design of the comparability project: 1) data characteristics produced by each survey at the same sites, 2) the overall condition assessment produced by each survey across 64 sites for the Maine Rivers IBI, and 3) the overall condition assessment produced by each survey across 64 sites for the NRSA fish Multimetric Index (MMI). Most Maine IBI metrics yielded similar results between the NELR REMAP and NRSA data, but the lack of biomass data in the NRSA method may have contributed to different results at selected sites. The percentage of fish with DELT anomalies tended to be higher with the NELR REMAP method and this may have been a result of the closer examination of fish that is inherent to that method by virtue of recording biomass data. The results also provide insights about the differences in the development and derivation of the Maine Rivers IBI and the NRSA fish MMI and the influence of both geographic scale and how metric choices are made.

Using standardized effect size as a supplement to traditional null hypothesis rejection in biological monitoring
Declan McCabe, Anne L. Burnham, State University of New York and Ismael Orengo, ESF Universidad Metropolitana, San Juan

Environmental scientists commonly use the arbitrary p value of 0.05 as a cutoff for determining whether a difference between sites or experimental treatments is significant. p values are influenced not only by the size of the difference of interest and the variance in the response variable, but also by the sample size. Sample sizes as low as 3 or 4 that are commonplace in environmental biology make it possible to reject the null hypothesis only if the size of the difference between treatments is quite large. Perhaps more importantly, p values associated with inferential statistics provide only a binary result. In the case

of a 2 sample t test, we can conclude that there or is not a difference between the treatments. There is nothing inherent in a p value that addresses the size or biological importance of a difference detected. Because the size of the difference, variance of the response variable, and the number of replicates all influence p values, there is little or no point in comparing p values across or even within studies. Measures of standardized effect size such as Cohen's D address this concern by expressing differences between treatments as standard deviations. By expressing differences in this way one can legitimately compare the sizes of differences between treatments regardless of the number or replicates, the scales of the measurements, or even the units used. Using such a metric means that we can address the size of a difference between treatments in ways that a p value cannot. This idea will be illustrated using 14 preferred macroinvertebrate metrics from the Environmental Protection Agency's rapid bioassessment protocols. The approach allows us to rank the metrics from most to least effective for detecting differences between Snipe Island Brook that drains mostly forested land and Potash Brook which drains mixed land use. The five metrics that best distinguished the sites were Number of Ephemeroptera taxa, % Ephemeroptera, EPT richness, Number of intolerant taxa, and % EPT. Finally the results will be compared with the responses of pond organisms to the total removal of duckweed, and the effects of bridges on stream benthos. In both the pond and the bridge studies, p values bracketed 0.05 despite there being robust differences as indicated by large standardized effect size. The latter studies illustrate the value of thinking past the p value in carefully interpreting data.

Macroinvertebrate Bioassessment Through Next-Generation Sequencing Project
Toby Stover, Hilary Snook and Katrina Kipp, EPA

States have long relied on the biological assessment of benthic macroinvertebrate communities to evaluate the ecological health of streams and to monitor the vulnerability of these aquatic systems to anthropogenic influences. Current approaches to identifying macroinvertebrates are costly and time-consuming, and many state and EPA scientists with this specialized expertise are retiring. New DNA-based Next-Generation Sequencing (NGS) procedures and the use and application of bioinformatics (i.e., application of information technology to the field of biology) hold great promise as tools that can augment current methods. A relatively new technology, NGS has revolutionized DNA sequencing in that hundreds of thousands of DNA sequences can be generated at the same time. In application to bioassessment, bulk (unsorted) environmental samples are extracted, amplified, and sequenced with NGS to create community profiles based on DNA barcode data. In addition, several bioinformatic techniques have been developed to allow multiple sites/samples (up to ~30 sites at a time) to be multiplexed (i.e., multiple primer sets targeting multiple DNA within a single PCR mixture) in the same NGS run, thereby reducing time and cost. The purpose of this project is to further develop this emerging technology in comparison tests in New England streams, with the objective of developing a new NGS protocol for biological assessments for New England that could be applied at regional and national scales. A side-by-side comparison of stream macroinvertebrate community indices derived from both DNA-based and morphology-based taxonomic assessments will be conducted by EPA Region 1 during 2014, in collaboration with EPA ORD and state partners. This project will demonstrate the capability of NGS to augment standard taxonomic stream bioassessments and to better discriminate the more subtle relationships between community assemblages and environmental parameters.

Poster Session
Wednesday 3/26/14 5:30 – 7:30

Early History of Lake Champlain as Documented in its Shallow Bays
Ashliegh Belrose and Andrea Lini, UVM Geology

Sediment accumulated on a lakebed archives information about past climate and changes in the regional environment. Two sediment cores were retrieved from Missisquoi and Saint Albans Bays, two shallow bodies of water located along the northeast arm of Lake Champlain, VT. The transition from Champlain Sea to Lake Champlain was captured in both bays, thus providing the opportunity to investigate the gradual ecological shift from a marine to lacustrine water body. The end of the Champlain Sea stage and the onset of Lake Champlain were controlled by isostatic rebound, and accompanied by significant changes in water level. This study aims to uncover the past environmental conditions of Missisquoi and Saint Albans Bay in order to better estimate the timing and duration of the marine to freshwater transition and the magnitude of the subsequent change in lake water level. Organic matter records (%C) were used to match and extend proxy records from previous studies in the same area. New radiocarbon dates on macrofossils show that new cores contain a record dating back at least 9600 cal yBP. Lithological analyses demonstrate that these two shallow water bodies responded differently to water level change, specifically during the low-stand of the Champlain Sea. The Saint Albans Bay record encompasses a 58 cm thick peat layer displaying evidence for a wetland occupying the bay during the earliest Lake Champlain phase. Based on the location of the peat in the core, we estimate a 7-8 m water level rise in the bay since 9600 cal yBP. Around the same time, the Missisquoi Bay core shows proof of an erosional unconformity in the form of a 2 cm thick deposit of sub-angular shale pebbles and sand, possibly alluding to a partial drying of the Missisquoi Bay basin. The lithology of the Lake Champlain phase is recorded as olive-green silty clay in both bays from the transition to the present. The Saint Albans Bay peat layer is being investigated for a shift in diatom assemblages and microfossil analysis of Missisquoi Bay sediment is underway. Both of these methods are used to examine in detail the progressive freshening over the course of transition from marine to lacustrine environment.

The Nose Knows: Bacteria Source Tracking with Canine Detection
F. Bell, E. DiFranco and W. Baker, FB Environmental, Portland ME
S. Reynolds and K. Reynolds, Environmental Canine Services, Vermontville, MI

Canine detection is an innovative, cost-effective method to identify human sources of bacteria in waterbodies. In 2013, FB Environmental and Environmental Canine Services worked with eight towns in southern Maine and coastal New Hampshire to develop comprehensive bacteria source tracking plans to address known or potential bacteria issues to their beaches and waterways. The dogs are trained to alert to the presence of human wastewater by performing a signal – Sable barks and Logan sits. Conventional bacteria tests were conducted alongside the dogs to determine the magnitude of pollution and the potential for other sources.

Stewarding of stage and temperature stream sensors by high school teams
Katie Chang, Vermont EPSCoR

The VT EPSCoR Center for Workforce Development and Diversity (CWDD) involves citizen scientist with the dual goal of engaging students in active research and creating a distributed data collection network. High school teams collect stream samples for nutrient and TSS analysis, and characterize macroinvertebrate communities. Beginning in 2012, high school student and teacher teams were also

trained to steward temperature and stage sensors. This poster will provide an overview of sensor use, provide a look at sensor data, and explore our next steps for improvements.

Spatial and temporal variation in aquatic insect emergence from headwater streams in New England
Kristin Cheney, and Robert F. Smith, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst, Allison H. Roy U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst

Temperature, hydrology, and habitat availability are important factors that affect aquatic insect emergence, and these factors may be influenced by changing climate and land cover. Community-wide emergence of aquatic insects has been understudied, and more research is needed to document timing of aquatic insect emergence and identify linkages between habitat availability and emergence patterns. The objectives of our study are to 1) investigate timing of Plecoptera and Trichoptera emergence from late spring to early fall and 2) characterize the spatial distribution of insect emergence in headwater streams. We collected emergent adult aquatic insects from four habitats: protruding wood, protruding rocks, submerged cobble, and submerged sand. Two forested headwater streams were sampled twice a week from May through October to determine patterns of emergence through time. We collected from three additional forested headwater streams twice a week for two six-week periods in the late spring and late summer to increase the trapping replication for the spatial analysis. Within the order Plecoptera, Ostrocerca (Nemouridae) peak emergence occurred May 6-9, Amphinemura (Nemouridae) peaked May 27-30, and Sweltsa (Chloroperlidae) peaked May 27-30. Leuctra (Leuctridae) had four peaks occurring between May 20 and August 22. Male and female Plecoptera had similar emergence timing, providing no evidence of a potential timing asynchrony for mating. Trichoptera families emerged throughout the study period. Lepidostomatidae had two distinct peak emergences, in both mid-May and the end of August, which suggests that this family was comprised of two species or cohorts in these streams. Plecoptera had the highest proportional abundance and richness in traps over wood (42.2%, 8 genera), followed by cobble (23.4%, 7 genera), rock (22.8%, 6 genera), and sand (11.7%, 6 genera). Trichoptera also had the highest proportional abundance and richness in the traps over wood (53.3%, 14 families), followed by protruding rocks (21.5%, 10 families), cobble (17.5%, 10 families), and sand (7.7%, 9 families). Deforestation and hydrological changes may cause a decrease in the amount of wood in the streams, which is an important habitat for emergence. Maintaining forested areas surrounding headwater streams will ensure that wood will be available for aquatic insect emergence.

Development of a Macroalgal Monitoring Protocol for the Great Bay Estuary, NH
Elisabeth Cianciola, University of New Hampshire

Eleven of the eighteen assessment zones in the Great Bay Estuary have been on the New Hampshire Department of Environmental Services' list of impaired water bodies due to high levels of nitrogen since 2008. Because of the role that runoff plays in the nitrogen load to this estuary, changes in its nitrogen concentrations may reflect increasing sewer discharge and impervious surfaces associated with population increases, land use changes in the watershed, or changes in precipitation patterns. Nitrogen fertilization can increase algal growth, which competes with and may stress rooted aquatic plants such as eelgrass. Research conducted in Great Bay Estuary between 2008 and 2010 showed a dramatic increase in the abundance of macroalgae since the last study, conducted thirty years earlier. To improve our understanding of the changes in macroalgae populations in response to nitrogen loading to the estuary, we collected data through three approaches: 1) continuing parts of the 2008-2010 macroalgal assessment; 2) assessing groundcover at 175 randomly selected points; and 3) comparing the nitrogen isotope ratios of macroalgae collected from various habitats. Whereas many previous studies have

focused on limited species, sites, or sampling events the preliminary data we have at this time illustrate the significance of macroalgae in the estuarine communities of Great Bay. Overall, our data corroborate the earlier results in suggesting that macroalgae is more prevalent in Great Bay now than it was thirty years ago. Our research also suggests potential directions for development of a long-term macroalgal monitoring program for the Great Bay Estuary.

A Proposed Agricultural Renaissance for New England – What about Water?
Betsy Colburn, Harvard Forest and Words & Water

Interest in local agriculture in New England is very strong. Efforts are underway in all six states to increase the sustainable production of vegetables, fruits, dairy products, meat, and eggs. "A New England Food Vision,"□ a thought-provoking new publication by local-food, public-health, and food-rights advocates from across the region(1) looks ahead 50 years at food consumption and nutrition, farmland, crop yields, potential food production, and food access. If this vision is realized, New England could produce all of its vegetables, half its fruit, some of its grain and beans, and all of its dairy products, meats, and eggs. Expanding grass-based livestock production is emphasized as a cost-effective and appropriate use for New England's landscape. Up to four million acres of forest, mostly on pre-1945 farmland, would be cleared, and much would support grass-fed dairy and beef cattle, hogs, sheep and goats, and poultry. Cattle would increase six-fold (to 900,000 animals), pigs, fifty-fold (2.6 million), sheep, forty-fold (over 2,000,000), and poultry, two-hundred-fold (over 300 million birds, many in back-yard flocks). Increased sustainable farming could benefit New Englanders greatly. However, there is potential for serious impacts to the region's waters. Water-resources agencies and organizations need to become actively involved in the ongoing planning and policy efforts, and to work with food advocates and the agricultural community to identify: · criteria for identifying lands that are and are not suitable for conversion to agricultural activities · measures for minimizing hydrologic impacts and degradation of water quality accompanying conversion of forests to pastures · conservation measures to protect urban and suburban water quality and quantity at up to 500,000 acres of community and market gardens and farms envisioned as producing fruits and vegetables for local consumers · best management practices that need to be implemented to ensure that changes in runoff, infiltration, base flows, and water quality are addressed in advance of substantially increased numbers of farm animals on the landscape · policy measures, including legal and regulatory changes and societal subsidies, that need to be implemented to ensure that small- and medium-scale farms across New England are able to - and do - apply necessary protective measures, so that an agricultural renaissance will not be accompanied by degradation of the physical, chemical, and biological integrity of the region's waters. (1) Donahue, Brian, et al. (Publication expected spring, 2014). A New England Food Vision. Ravenmark Press, Montpelier, VT. 44 pp.

Relating biological condition to streamflow and temperature regimes in streams with USGS gaging stations in the northeast
James Coles and Karen Murray, USGS NY Water Science Center

Last year at NEAEB (2013), we described a study that was initiated by the USGS National Water Quality Assessment Program (NAWQA) to investigate the effects of altered streamflow and thermal regimes on the biological condition of streams in the Northeast. This poster provides an update to the investigation. During the summer of 2013, site reconnaissance was conducted across the region at locations with USGS gaging stations, and 75 sites were selected and outfitted with data loggers to monitor air and water temperatures. Sixty of the sites are small rivers and streams (TNC classification, less than 200 square-mile watershed), and collection of macroinvertebrate and benthic algal samples are planned for this field season (2014); sampling fish communities may be an option. Ultimately, we think that the results of

the investigation may be useful to our partners, such as in following examples: (1) Quantify changes in the biological condition of streams that occur when flow and thermal regimes are altered; (2) Identify streams where thermal regimes have shifted from the expected natural temperatures; and (3) Identify indicator taxa that are sensitive to changes in flow patterns and water temperature.

The Massachusetts Estuaries Project

Christine Duerring, Massachusetts Massachusetts DEP, Division of Watershed Management, Watershed Planning Program

The Massachusetts Estuaries Project (MEP) is a $12.5 million dollar project to evaluate, model, and set nitrogen loading limits in 70 embayment systems in Southeastern MA including Cape Cod, Buzzards Bay, and the Islands of Nantucket and Martha's Vineyard. The majority of these estuaries are fairly shallow embayments whose watersheds have changed significantly in the last 50 years from intense development pressure. With this development comes increased nitrogen loading into the estuaries from predominately septic systems but also to a lesser extent stormwater, fertilizers and agriculture. This excess nitrogen has caused declining coastal habitat quality in the form of loss of eelgrass, increased macro-algae and algae blooms, low dissolved oxygen and adverse changes in plant and benthic animal diversity. The goals of the MEP are to evaluate the water quality status of the embayment systems, develop protective nitrogen thresholds and loading limits for each embayment, and provide a consistent methodology and tools to investigate and define acceptable nitrogen remediation strategies. The technical study on each embayment is conducted by UMass Dartmouth School of Marine Science and Technology (SMAST) and is based on a linked model approach that combines site specific land use loading information, embayment hydrodynamics and water quality data. Ultimately the specific nitrogen threshold and loading information from each embayment is then used by MassDEP to develop TMDLs for nitrogen management for the watershed. Towns use these TMDLs to guide their comprehensive wastewater management planning process. The Linked Model can also be used to evaluate alternative loading scenarios so the towns may evaluate the most cost effective way for them to address the TMDL to reduce nitrogen inputs to the embayment. To date, comprehensive nitrogen loading studies have been completed on approximately 57 of the 70 embayments. TMDL development is in process on many of these but MassDEP and SMAST have a ways to go to complete the process. The MEP is a collaborative effort of the embayment watershed towns, MassDEP, SMAST, Applied Coastal Research and Engineering, Inc, Cape Cod Commission, USGS, EPA, Massachusetts Coastal Zone Management and Massachusetts Division of Marine Fisheries. MassDEP provided $6.5 M through the Environmental Bond Fund to do this work and matching funds came from the towns as well as other collaborators.

Review and Evaluation of BMP Tracking Systems for Assessing Nutrient Load Reductions in the Long Island Sound Watershed

Ken Hicker, WaterVision, LLC.

Quantitative BMP tracking systems were reviewed and evaluated for suitability to track nitrogen reductions throughout the Long Island Sound (LIS) watershed. A tracking system that quantitatively tracks NPS control measures, such as urban stormwater and agricultural BMPs, is required to assess the progress of LIS TMDL implementation. Working collaboratively with the LIS TMDL and NPS workgroups, we identified the needs of an LIS watershed BMP tracking system and evaluated available systems for suitability. A suitable tracking system needs to be able to accurately estimate pollutant load reductions from a wide variety of NPS control measures within a common framework. The tracking system must be capable of aggregating sets of NPS control measures and calculating the resulting total pollutant load

reductions within specific watershed areas. This watershed-level pollutant load reduction estimate will then be updated periodically (e.g., annually) to provide an assessment of progress toward NPS load reduction targets. Ideally, tracking systems may also support watershed planning and cost-benefit analysis by providing estimates of pollution reduction and associated costs for specific candidate BMPs. The review of available BMP tracking systems began on a national scale and eventually focused on systems currently used in the Chesapeake Bay region and systems currently under development in New England. The features of available BMP tracking systems were compared to the requirements of the LIS BMP tracking system. Several available BMP tracking systems were found to have readily adaptable components. Several key factors emerged as important in evaluating BMP tracking systems. These factors included the specificity of pollutant removal efficiency calculations, the method of estimating pre-BMP pollutant loads, and the approach for specifying characterizing off-site attenuation of pollutant loads. This poster will provide a description of the realm of available BMP tracking systems and the process applied to screen these systems for suitability for the LIS NPS control measure tracking application. Recommendations for an LIS BMP tracking system design and next steps in developing the system will also be discussed. This BMP tracking system evaluation and associated findings may be of interest to practitioners working to track nutrient loading reductions in other major watersheds, such as Lake Champlain, Great Bay, and the Charles River, throughout the region.

Suspended Sediment Prediction Using Artificial Neural Networks and Local Hydrometeorological Data
Scott Hamshaw, Donna Rizzo, Kristen Underwood, University of Vermont

As the climate in the Northeast is expected to feature greater and more frequent precipitation events and winter rainfall, the potential for increased sediment loading from erosion processes in the watershed and along the channel are high and a major concern for water resource managers and other stake holders. Excessive sedimentation and deposition can negatively affect aquatic habitat and nutrients associated with eroded sediments are a major source of impairment to surface waters including Lake Champlain. Typical sediment monitoring comprises periodic sampling during storm events and is often limited to gauged streams with flow data. Continuous turbidity monitoring offers high-resolution, temporal measurements to better quantify the total sediment loading occurring during and between storm events. Artificial neural networks (ANNs), that mimic learning patterns of the human brain, have been effective at predicting flow in small, ungauged rivers using local climate data. This study advances this technology by using an ANN algorithm known as a counter-propagation neural network (CPN) to predict discharge and suspended sediment in small, ungauged streams. The first distributed network of continuous turbidity sensors was deployed in Vermont in the Mad River Watershed, located in Central Vermont. Periodic sampling of total suspended solids (TSS) during storm events enabled turbidity versus TSS relationships to be established. The Mad River and five tributaries were selected as a test bed because seven years of periodic turbidity sampling data are available and it represents a range of watershed characteristics. In sub-watersheds with monitored turbidity, stage, 15-minute precipitation, soil moisture and air and water temperature data were also collected and used as inputs to the CPN. Stage sensors and theoretical rating curves are used to validate the flow predictions from the CPN. The real-time turbidity data are used to train and test the suspended sediment predictions from the CPN network at each site. The turbidity data are also used for training the CPN on a subset of tributaries and testing on the remaining subwatersheds. Reasonable estimates of suspended sediment discharged from the tributaries and the main stem of the Mad River are calculated and compared enabling a more reliable foundation for building a sediment budget. Results of this study will assist managers in prioritizing mitigation projects to reduce impacts of sediment loading.

The Effect of *Dreissena polymorpha* on the Native Mussel Species in the Missisquoi Bay
Hannah Kittler and Declan McCabe, Saint Michael's College

Zebra mussels (*Dreissena polymorpha*) have become an invasive species in Lake Champlain, and have altered macroinvertebrate habitat significantly. They have been negatively affecting the native mussel species by attaching themselves to the mussels and eventually killing them. Missisquoi Bay has just recently been colonized by zebra mussels and represents an opportunity to study the effects of a new invasion. I hypothesized that when the abundance and species richness of the native mussels *Elliptio complanata, Lampsilis radiata, Lampsilis ovata, Pyganodon cataracta, Pyganodon grandis*, and Pisidiidae increased, the number of zebra mussels would increase as well. My results showed that there was a significant increase in the number of zebra mussels with higher native mussel richness. There was also an increase in the number of zebra mussels when native mussel abundance was higher, but this effect was not statistically significant. The results also showed that there was a positive difference in the number of native mussels in samples with zebra mussels compared to samples with no zebra mussels, for all native mussels, except *Elliptio complanata*. This could be because of *Elliptio complanata's* large abundance in the Missisquoi Bay, and that it is slightly tolerant of zebra mussels. These results support my hypothesis, and show that the abundance and richness of native mussels are affecting the number of zebra mussels present. This is important because zebra mussels are becoming more invasive and altering the environment that many organisms live in. It is important to see how they are changing the environment, and what effects they will cause in the future.

A Paleolimnological Assessment of Lake Champlain's Trophic Status
Andrea Lini and Suzanne Levine, UVM Geology, and Milt Ostrofsky, Allegheny College

Changes in land use and human population growth in the Lake Champlain basin since 1760 have had significant impacts on the trophic status of the lake. Due to the lake's large size, multiple basins and complex mixing patterns, however, the timing and intensity of eutrophication have varied between lake regions. To assess eutrophication at a decadal scale, we have collected sediment cores from twelve widely spaced sites and analyzed them for a suite of paleolimnological indicators of productivity, nutrient conditions, and algal community structure. All analyses suggest that the sub-basins of Lake Champlain are naturally oligotrophic and that despite substantial deforestation, and agricultural and commercial activity on and around the lake, productivity and nutrient accumulation rates changed little prior to late 19th century. Increased organic matter accumulation in sediments is first apparent in layers deposited in the late 19th century, although logging and land clearing had begun more than a century earlier and had deforested ~70% of the Basin by 1870. C/N and C stable isotopes point to a progressive increase in the contribution of autochthonous organic matter to the sediment. This is especially evident for the post-1950 records. Enhanced aquatic productivity can also be inferred from the algal pigment accumulation profiles. These show low values until ca. 1930, after which pigment accumulation rapidly increases to reach peak values between 1970 and 1990, depending on lake region. Locally, productivity appears to have declined during the past decade. This is in agreement with the sediment P accumulation data, which also show signs of possible amelioration after peaking inthe '80s and '90s. Total sediment accumulation rates are highly variable within Lake Champlain but at all sites are greater at present than they were pre-settlement.

Observing the Correlation Between Algal Bloom Biodiversity Variation, Spatial Distribution and Abiotic Aquatic Conditions

Jessica Mailhot, EPSCoR RACC

Modern accelerated climate change is stressing the complex interrelationships between biota and its physical environment and demanding the rapid acclimation of biota. Eutrophication of temperate freshwater lakes is one such process that is generally being accelerated by climate change due to increasing annual average temperature and precipitation. One phenomenon that accompanies eutrophication is extreme seasonal algal blooms, such as the annual one in Missisquoi Bay, the northernmost region of Lake Champlain. The bloom is neither spatially or temporally uniform. This study aims to document how the varying qualities of water at 12 discrete sites in the bay influence the biodiversity and competition of the algae over the course of the bloom event. Each site was visited thrice, during the pre bloom, peak bloom, and post bloom; temperature, depth, pH and dissolved oxygen content were recorded along the water column, and fresh algae samples were taken from the surface. The biovolume of each genus was calculated using a FlowCAM fluid imager and used to group sites of common genus ratios together using cluster analysis. The water quality parameters of these clusters were graphed relative to the bay's average readings for that sampling day to illustrate which parameters drive biological community dynamics. Few distinct relationships between the water parameters and communities could be discerned, but the spatial orientation of the sites is consistently a strong determinant of related community structure. Finally, site S027 proved to be the most constantly diverse and resistant to the otherwise uniform domination of cyanobacteria over the duration of the bloom; due to its proximity to a river outlet and very shallow depth its water quality differed greatly from the rest of the bay and therefore supported a different host of algae genera.

Predicting artificial light pollution around The University of Massachusetts campus

Laura McPherson and Robert Smith, Mass Cooperative Fish and Wildlife Research Unit

Land development alters terrestrial and aquatic systems. Artificial night lighting is one example that affects all types of ecosystems and their inhabitants. Animals and plants that use natural light as cues for life history processes and behaviors are most at risk to artificial light. Artificial lighting can disorient animals and affect their migration and reproduction, among other activities. Light from commercial areas has the potential to decrease the amount of visible stars as well as moonlight and to disturb ecosystems. Sources of illumination include, but are not limited to, streetlights, building lights, vehicle headlights and floodlights. We performed a pilot study to determine the feasibility of predicting light pollution at a scale that is relevant to an individual organism. We aim to find out if general GIS data of land cover can predict light pollution as accurately as manually derived spatial data on individual anthropogenic structures. We deployed HOBO light sensors in forested areas within 1, 5, 10, 25, 50, and 100 meters of an institutional land cover class (i.e., the campus of the University of Massachusetts-Amherst). The sensors were placed above ground cover and deployed before sunset and collected after sunrise. We measured light intensity in lumens and temperature in 10-minute intervals. We compared light intensity measurements to surrounding land cover types and individual human structures using simple mathematical models (e.g. linear regression) to determine if the amount of light pollution could be predicted on a fine scale. We also evaluated other components that may affect the light pollution at particular distances from certain sources and land types.

Macroinvertebrate community impacts, recovery, and resilience at long-term reference streams following flooding from Tropical Storm Irene

Aaron Moore and Steve Fiske, Vermont Department of Environmental Conservation

In late August 2011, Tropical Storm Irene caused massive flooding throughout Vermont. Record high flows led to massive erosion and scouring in the state's rivers and streams. The timing of this event directly coincided with the beginning of the state biomonitoring program's fall index period. Within a week of the storm we were able to begin conducting our annual fish and macroinvertebrate assessments. This field work included surveys at several long-term references sites throughout the state that have been monitored annually for over a decade. In early 2012 we presented data describing the effects of the storm on macroinvertebrate communities at these reference sites. Specifically, high flows and scouring caused a dramatic decline in macroinvertebrate densities, causing this metric to fail our Class B criteria at all affected sites. However, total richness, EPT richness, and most other metrics used in our stream biocriteria were maintained at typical reference levels. This finding indicated that while communities were severely affected by these extreme flood flows, they should have the capacity to recover quickly. In this poster presentation we will report on the recovery of macroinvertebrate communities at these long-term monitoring sites through fall 2013, two years after Irene. This will include both the effects of repopulation on biocriteria metrics, as well as trends in individual populations. Implications for climate change will also be discussed.

Assessing the statewide biological condition of Vermont's flowing waters: Results of a probability-based survey, and comparisons to regional and national assessments

Aaron Moore and Steve Fiske, Vermont Department of Environmental Conservation

The Vermont Department of Environmental Conservation (VTDEC) biomonitoring program has been conducting macroinvertebrate and fish community assessments throughout the state for over 30 years. However, many of these assessments have targeted streams and rivers in response to known or suspected stressors, and therefore don't allow for an unbiased representation of the overall condition of the biology of the state's running waters. In 2002, VTDEC implemented a probability-based biological assessment of Vermont's wadeable streams. This probabilistic survey was designed to assess up to 75 randomly selected stream sites over a 5 year period, coinciding with our already established rotational watershed monitoring. This assessment was also intended to overlap and supplement the EPA's national rivers and streams assessments occurring every 5 years. VTDEC recently completed its second probabilistic survey in 2012. Data show that a large majority of stream miles in the state exceed Class B biocriteria standards, and that 45% of stream miles are assessed as 'Very Good' or 'Excellent'. Comparing fish and macroinvertebrate assessments, there was a much higher proportion of macroinvertebrate communities rated as 'Excellent' (50% vs 10%). In contrast, fish communities were more often rated as 'Poor' when compared to macroinvertebrates (12% vs 2%). Potential stressors impacting these communities include acidity, nutrients, sediment, hydrology and chloride. Overall findings are discussed in comparison to the results of VDEC's first probabilistic survey. For example, in the current survey there were a higher percentage of stream miles that did not pass Class B standards, though this difference is not significant. We also address results of the current statewide survey in relation to the regional and national results of the EPA's National River and Stream Assessment (NRSA 2008-2009), along with the difficulties involved in this type of comparative evaluation.

An Investigation of Mercury Concentrations in Stream Water, Macroinvertebrates, and Juvenile Brook Trout in Response to Liming in an Adirondack watershed

Karen Murray, Douglas A Burns, Gregory B. Lawrence, U.S. Geological Survey, Charles T. Driscoll, Syracuse University, Daniel C. Josephson and Clifford E. Kraf, Cornell University

Acid precipitation has resulted in the reduction or complete loss of fish populations in many high-elevation forested lakes across New York's Adirondack region. While chemistry of many lakes has shown recovery since the implementation of the Clean Air Act of 1990, and its amendments, the recovery of native fish populations has been slow or nonexistent in many lakes. Honnedaga Lake, a small (310 ha) lake located in the western Adirondacks, supports a heritage strain of brook trout (*Salvelinus fontinalis*). Although population density has increased in recent years, the rate of increase is much slower than expected, given the improvements in lake chemistry. This lag has been shown to be due to the continued chronic or episodic acidification of many tributaries, which results in reduced spawning success in those critical habitats. Since 2010, experimental in-stream and watershed liming of Honnedaga Lake tributaries has been studied as a method for accelerating recovery and improving brook trout recruitment in this and other acid-impacted lakes. Liming-related changes in stream water chemistry (especially pH, dissolved organic carbon [DOC], and sulfate), and trophic ecology, however, have major implications for mercury (Hg) cycling and bioaccumulation, and liming may have the unintended consequence of increasing the production, transport, and bioaccumulation of Hg. Hg species, DOC, sulfate, stable isotopes (in biota), and other constituents were assessed in stream water, macroinvertebrates, and juvenile brook trout from limed and untreated tributaries, from reaches above and below in-stream liming, and before and after treatment, to document the effects of liming on Hg cycling and bioaccumulation. Pre-liming median methylmercury (MeHg) concentrations in crayfish (Cambaridae) varied widely among five sites sampled in July 2012 (i.e., 60 ng/g – 1,050 ng/g dry weight), and were related to concentrations of DOC and aqueous MeHg, which ranged from 3.2 ng/L to 13.3ng/L, and from 0.06 ng/L to 4.80 ng/L, respectively. Median concentrations of total Hg (assumed to be primarily MeHg) in young of year brook trout (n = 3 per tributary) from three tributaries ranged from 38 ng/g to 116 ng/g (wet weight), with the highest concentrations found in fish from the tributary with the highest DOC and aqueous MeHg concentrations. Post-liming data received thus far indicate that DOC concentrations increased in limed sites relative to those of nearby untreated reference sites. Post-liming MeHg data for water and biota will be used to evaluate potential effects of these changes on mercury cycling and bioaccumulation in these streams.

Life history characteristics of alewife (*Alosa pseudoharengus*) in freshwater environments

Benjamin I. Gahagan, Massachusetts Division of Marine Fisheries, Adrian Jordaan and Andrew R. Whiteley, University of Massachusetts Amherst, Julianne Rosset, Massachusetts Cooperative Fish and Wildlife Research Unit University of Massachusetts Amherst, and Allison H. Roy, U.S. Geological Survey Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst

Every spring, alewives (*Alosa pseudoharengus*) begin their annual spawning run into lakes and ponds along the northeastern coast of the United States. Adults provide a significant source of marine-derived nutrients to freshwater systems and young of year act as an important food source for piscivorous fish. Over the past two centuries coastal migratory alewife populations have drastically declined due to habitat degradation, overfishing, and the blockage of critical spawning rivers by dams. Alewife populations are typically assessed by counting adult fish as they enter spawning habitats but seldom account for the resulting production within the natal nursery. As a result, there is a lack of data pertaining to juvenile life history and factors that influence nursery productivity. The objective of our research is to examine alewife young of year age, mortality, and growth rates among 20 freshwater

lakes and ponds in eastern Massachusetts. In summer 2013, we relocated 428 adult fish in three separate pulses to an isolated but previously occupied pond and sampled their juvenile offspring every two weeks throughout the summer. This study will be expanded in summer 2014 to include lakes and ponds with existing runs and estimates of adult escapement, allowing us to examine the effects of landscape characteristics and habitat quality on juvenile age, growth, and mortality. Our research will help develop a stronger understanding of the role of habitat quality and cohort dynamics while improving alewife restoration throughout their native range.

Intraspecific competition between two invasive snail species (*V. piscinalis Vs. B. tentaculata*) in Missisquoi Bay
Robert Ryan and Declan McCabe

Both the European valve snail (*Valvata piscinalis*) and the Faucet snail (*Bithynia tentaculata*) are exotic species in Missisquoi Bay of Lake Champlain. They are known for their high tolerance to adverse environmental conditions and fairly long lifespan. They are efficient feeders and can survive in a variety of habitats. Both gastropods have the potential to be highly competitive with other species for food and space because of their rapid growth rate and high fecundity. I hypothesize that the Valvata and Bithynia snails will affect each other abundance negatively and also will affect other snail species as the combined abundance of Valvata and Bithynia increases. To prove my hypothesis over 332 macro invertebrate samples were collected in Missisquoi Bay using a petite Ponar instrument and taken to the lab to be sorted and identified. I used a null-model to investigate if snails tended to co-occur less frequently than would be expected if snails were randomly distributed. The C-score value for the data matrix indicates that snails co-occurred less frequently than would be expected based on a random distribution. By comparing and analyzing the data collected on both Valvata and Bithynia snails at each site, I determined C-score values, p-values and population densities. Data analysis shows positive correlation between both gastropods with little competition in high population density areas. Furthermore, a bar graph shows higher abundance of both invasive snails than native gastropods, suggesting that competition between both invasive species affect other freshwater native snail abundance.

The potential for restoration of Tan Brook, an urban headwater stream in Amherst, Massachusetts
Alison Tenhulzen, Robert Smith, and Alyssa Black, University of Massachusetts Amherst

The Tan Brook, found in Amherst, Massachusetts, is a headwater stream primarily confined to underground culverts, only seeing daylight in 27% of the stream. Being underground, the Tan Brook is often out of sight and out of mind for local residents and students at the University of Massachusetts Amherst, where the stream deposits into the campus pond. The ultimate goal of this research, which is ongoing, is to increase community awareness for the health of the Tan Brook, collect baseline environmental quality data, and determine potential courses of restoration or remediation. This poster highlights the challenges encountered with restoring an urban stream, evaluates potential pre-restoration assessments for headwater streams in highly urbanized environments, and assesses the potential remediation of aesthetics and non-ecological endpoints. Analysis of the Tan Brook watershed was performed with ArcGIS to determine the ability to daylight the stream, the percentage of private land neighboring the stream, and measures of other variables that may influence restoration success. Since the Tan Brook runs through the heart of Amherst, the community must be educated and involved in any restoration efforts, as daylighting the stream would have an effect on the town infrastructure. It is our hope that our multidisciplinary analysis of the Tan Brook watershed will serve as a model for future

efforts managing highly modified headwater streams. Additionally, this research is intended to show how the "campus stream"? can be used as an educational and research tool for campus communities.

Assessing effects of surface water supply reservoirs on stream hydrologic and thermal regimes in Massachusetts

Allyson N. Yarra, University of Massachusetts Amherst, Allison H. Roy, U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst and Todd A. Richards, Massachusetts Division of Fisheries and Wildlife

Humans have altered water resources to meet the demands of a rapidly-growing population, resulting in negative impacts on stream ecosystems. For example, impoundments and surface water extraction have the potential to cause indirect, yet severe consequences for aquatic organisms. From a managerial perspective, relationships between water allocation and environmental flows have focused primarily on water quantity rather than quality. While water temperature is linked to the ecological health of streams and their biota, thermal alteration associated with impoundments is less studied relative to stream flow alteration. We compared thermal regimes between streams impounded by surface water withdrawal reservoirs, unmanaged reservoirs, and unimpounded reference streams. Additionally, we examined the effect of stream stage on thermal regimes. We installed vented pressure transducers in streams within small watersheds in central and eastern Massachusetts in summer 2012. Transducers measured temperature and pressure (water level) every 15 minutes. On average, both winter (January) and summer (July) temperatures were notably higher (0.2-5.1°C) in the regulated streams relative to the reference streams. Maximum July temperatures ranged from 22.2 to 29.9°C across sites, and the streams with surface water withdrawal reservoirs exceeded those measured in nearby reference streams by 3.4 to 6.9°C, suggesting that reservoirs warm downstream waters. Watershed area, lake morphometry, groundwater inputs, water supply activities (e.g., amount, location, and timing of water releases and withdrawals), and other site-specific characteristics may explain the variation in temperature differences between regulated and reference stream pairs. Our results may be used to generate an understanding of the aspects of hydrologic and thermal regimes linked with biotic impairment, including the potential impacts of surface water withdrawals on stream biota.

Twelve years on the Lower Kennebec River, Maine 2002-2013: Fish assemblage composition and responses with diadromous fish management

Chris Yoder, Midwest Biodiversity Institute

We conducted systematic sampling of the fish assemblages of the lower Kennebec River, Maine during a consecutive 12 year period, 2002-2013. Seven locations between the Lockwood Dam in Waterville and the head of tide at Augusta were sampled each year during a July - early October seasonal index period. The purpose of this survey was to infer changes in fish assemblages following the removal of the Edwards Dam in 2000. This was also part of a larger survey of riverine fish assemblages throughout Maine in 2002-2007 and throughout New England in 2008-9. In 2008 three sites were added on the lower Sebasticook River, a major tributary. These sites were sampled in 2008-2013 in follow-up to the removal of the Ft. Halifax Dam in Winslow, Maine. The initial response to the Edwards Dam removal was an overall increase in the numbers and biomass of the resident freshwater species. The development of the Maine Rivers Index of Biotic Integrity (IBI) which was developed for the moderate-high gradient rivers throughout Maine and northern New England was employed along with its component metrics after its development in 2007. In 2008 we added four diadromous metrics to include responses by that component of the fish assemblage. This modification to the Maine Rivers IBI includes diadromous species where they are expected to be present and without altering the structure of the IBI for the

native inland fish assemblage. Since 2008 the overall IBI has increased consistently in the lower Sebasticook and also in the lower Kennebec. These increases were due to the greater abundances of young-of-year Clupeidae (mostly river herring) that begin to appear in the late summer and early fall as the annual outmigration occurs. Other diadromous species such as American eel are an important contribution as well, but numbers have varied over the past 6-7 years. Striped bass showed the most variable results being abundant in some years and nearly absent in other years. Atlantic salmon encounters were the most numerous in 2011 equaling all prior years combined, but few if any were observed in 2012 and 2013. Shortnose and Atlantic sturgeon were observed only in 2012 and at isolated sites in the lower Kennebec. The management of flows for American eel passage beginning in 2009 altered fall sampling conditions. The variable results among certain species and metrics emphasizes a need to continue this long term dataset.

Big Picture Plenary Session: Implementing the Clean Water Act in the Modern Era
Thursday 3/27/14 8:00 – 10:00

Pete LaFlamme, Director of Vermont Department of Environmental Conservation's Watershed Management Division, Jon Erickson, Professor and Interim Dean of the Rubenstein School of Environment and Natural Resources, Jim Murphy, Senior Counsel for the National Wildlife Federation , David Mears, Commissioner of Vermont's Department of Environmental Conservation and Diane Switzer, Regional Monitoring Coordinator, EPA New England Office of Environmental Measurement and Evaluation

Five experts in clean water policy will discuss current challenges and opportunities for protecting aquatic ecosystems. In a dialogue moderated by Ethan Swift, of Vermont Department of Environmental Conservation's Monitoring, Assessment and Planning Program, these speakers will provide their unique perspectives on how scientists and policy makers must work together to achieve the promise of the Clean Water Act to ensure the biological, physical and chemical integrity of the nation's waters.

Pete LaFlamme will discuss the opportunity for state regulatory agencies to transition to a new paradigm for protecting water quality. Director LaFlamme will draw on his more than two decades of work implementing the Clean Water Act to identify new methods necessary to address the gaps in existing law and policy and to solve the next generation of water pollution problems.

Jon Erickson will discuss how water quality must be viewed as a critical component of our quality of life. Dean Erickson will bring his considerable expertise in ecological economics to bear on the question of how we help the broader public and elected officials understand the true value of our natural resources and a clean environment.

Jim Murphy will bring the perspective of a long-time and effective advocate for the protection of the nation's waters to the discussion. Senior Counsel Murphy will focus on the critical need to ensure that our efforts to address water pollution are motivated and informed by the need to prevent or respond to dramatic disruptions to aquatic ecosystems resulting from climate change.

David Mears will describe the foundational role that science and scientists must play as leaders of efforts to transform our system of water quality protection. Commissioner Mears will describe the need to bring scientists to the fore in efforts to design new policies that respond to our current and evolving understanding of the greatest threats to aquatic ecosystems.

Diane Switzer will discuss the recently released Waters of the United States proposed rulemaking by EPA and the Army Corps of Engineers. The proposed rule will clarify protection under the Clean Water Act for streams and wetlands that form the foundation of the nation's water resources. Determining Clean Water Act protection became confusing and complex following Supreme Court decisions in 2001 and 2006. For nearly a decade, members of Congress, state and local officials, industry agriculture, environmental groups, and the public asked for a rulemaking to provide clarity. The proposed rule clarifies protection for streams and wetlands and the proposed definitions will apply to all Clean Water Act programs. It does not protect any new types of waters that have not historically been covered under the Clean Water Act.

Technical Plenary Session: Biocriteria Development – Beyond Streams
Thursday 3/27/14 10:30 – 12:00

Biological criteria program - current and future work
Hilary Snook, USEPA Region 1

An important part of protecting or restoring aquatic ecosystems is establishing quantitative targets for assessing biological condition (e.g. designated aquatic life uses and numeric biological criteria) and understanding the relationship between stressors and their impacts on the biology. Stream condition assessments in the U.S. are typically based on surveys of benthic macroinvertebrates and/or fish assemblages conducted at reference sites. Ideally, reference sites are undisturbed by anthropogenic stress. However, the impact of human activities on aquatic systems is pervasive and reference sites may be significantly impacted. Additionally, selecting reference sites for unique aquatic systems such as large rivers, lakes/reservoirs, estuaries and coastal ecosystems may not be feasible. Beyond setting quantitative targets for biological condition, understanding the impacts of stressors is critical for establishing protective levels of stressors and gauging restoration. This purpose of this presentation is to provide information on current efforts by the USEPA to assist State and Tribal Water Quality Programs to develop and implement biological criteria.

Fast Tracking Lake Biocriteria in Minnesota
Jacquelyn Bacigalupi, Minnesota Department of Natural Resources

Assessing the health of biological communities in Minnesota's lakes, streams, and wetlands is a key component of the overall Clean Water assessment process. Biological assessments provide important information that complements water quality sampling efforts. In Minnesota, lakes, streams, and wetlands are assessed within a major watershed approach on a 10-year cycle. Currently lake assessment focuses on trophic state and its relation to supporting or not supporting designated uses, specifically swimming and aesthetic uses. The Minnesota Department of Natural Resources (MDNR) is developing and implementing biological assessment methods for lakes. While a smaller scale effort to develop a fish-based lake Index of Biotic Integrity (IBI) began in the 1990s by Fisheries researchers, the force behind developing state-wide fish and plant-based IBIs for lakes was funding provided by the passage of the Clean Water, Land and Legacy Amendment to the Minnesota Constitution by Minnesota voters in 2008. The Legacy Amendment increased the state sales tax by three-eighths of one percent. Approximately 285 million dollars generated by this tax is appropriated annually to fish and wildlife, clean water, parks and trails, and arts projects, with clean water receiving one-third of the funds. The lake IBI development and implementation project receives 1.4 million dollars from the clean water

portion each year. In addition to funding, this effort required comprehensive thinking and coordination. Implementation of fish IBI sampling within a watershed assessment framework has involved adjustments to survey methods, survey schedules, and staffing across 24 fisheries management areas. It has also required close cooperation with other MDNR Divisions and with the Minnesota Pollution Control Agency (MPCA). A final fish-based IBI is anticipated to be in use by early 2015 and an aquatic plant community approach within the next several years. MDNR Fisheries leadership is committed to fish community sampling in lakes in order to leverage Legacy Amendment dollars, deepen our understanding of lakes as systems, bring more science to TMDL planning, and examine long-term trends in fish communities across the state.

What do the plants say? Using aquatic macrophytes to assess ecological integrity
Alison Mikulyuk, Wisconsin Department of Natural Resources

Ecological assessments can serve as a yardstick with which to measure restoration outcomes; they can also help identify low- or high-quality environments and define management priorities. Ecological assessments of freshwater ecosystems are particularly informative because aquatic systems reflect broad-scale impacts (everything flows downstream) and integrate environmental stressors occurring on land and water. Yet our ability to assess the ecological integrity of inland lakes is limited. Nutrient status and phytoplankton abundance are often used to evaluate lake ecological integrity, but these indicators only reveal part of the story. For example, increasing nutrient inputs to a shallow lake will often encourage the growth of tolerant macrophyte species before impacts to phytoplankton abundance are evident. In addition, the ability of macrophytes to sequester nutrients and encourage the settling of phytoplankton may obscure the actual magnitude of stress experienced by the system. Macrophytes respond to diverse stressors such as nutrient pollution, sedimentation and shoreline development, and they do so on relatively short time scales. In this talk, I will discuss opportunities to use aquatic macrophytes as subjects of bioassessment by highlighting the conceptual links between macrophyte functional traits, community composition, and anthropogenic disturbance.

SLAM Session
Thursday 3/27/14 1:00 – 3:00

Believing that Science Still Has a Place at the Policy Making Table: The Story of Vermont's Shoreland Protection Bill
Kellie Merrell, Vermont Department of Environmental Conservation

In 1970, Vermont was one of the first states in the nation to pass a shoreland zoning law. In 1971, Maine copied Vermont's law. In 1975, Vermont repealed its law, while Maine went on to implement its law and make improvements to it over time. It is the author's opinion that Maine's law and specifically its minimum standards are the most protective in the nation. Meanwhile, to date, Vermont lacks any minimum mandatory statewide standard. VTDEC conducted studies from 2005 to 2009 that found that the way Vermonters were developing their lakeshore was in conflict with the Vermont Water Quality Standards for aquatic biota and habitat. In 2011, Tropical Storm Irene devastated Vermont and the legislature asked VTDEC to recommend ways to make Vermont more resilient to future extreme weather events. VTDEC took this opportunity to highlight the need for shoreland protection. It highlighted findings from two independent studies conducted by VTDEC; the 2007 National Lake Assessment and the 2005-2011 Littoral Habitat Assessment. The key findings of both reports were both simple enough for non-scientist policy makers to understand and compelling enough to motivate them to act. In 2013 the Vermont House passed the Shoreland Protection Act, 105 to 42 and in 2014 the

Vermont Senate passed it 22 to 6. While the combined study results cited took close to a decade to collect, analyze and compile, the window of attention such results got by policy makers and the public was brief. The five minute elevator pitch or SLAM is sometimes all a decade or more of research gets to influence key policy makers or media outlets. The key scientific sound bites that had their day in the policy arena will be pitched to the audience in this presentation. The discussion to follow will delve more into the details of how the science of lakeshore development got a seat at the policy table, 43 years after it had done so originally and what lessons we can learn from this experience.

Examining effects of winter water level drawdowns on fish populations in New England lakes
Jason Carmignani, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst and Allison H. Roy, U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst

Annual winter water level drawdown is a common management tool in New England lakes, ponds, and reservoirs. Winter drawdowns are conducted to control nuisance levels of submergent macrophytes, prevent ice damage on human-built structures, gain access to perform maintenance, and permit flooding storage among other purposes. Despite the prevalence of drawdowns, few studies have examined the ecological impacts on the littoral zone community in New England, particularly on fish assemblages. We conducted a review of journal articles, reports, and other documents examining the effects of winter drawdowns on littoral zone flora and fauna. Through direct and indirect pathways, annual winter drawdowns significantly alter composition and reduce richness of submergent macrophyte and benthic invertebrate assemblages, with sites with the highest drawdown amplitudes (i.e., high lake bottom exposure) experiencing the most severe assemblage shifts. Insectivorous fish species show relatively low abundances in winter drawdown systems, suggesting a link between fish assemblages and habitat and food resources. However, most of these research findings are based on research in boreal (e.g., Scandinavia) and north temperate water bodies with large (e.g., >2m) drawdowns, and the results may not translate to New England lakes that undergo relatively mild drawdown amplitudes (e.g., <2m). We aim to examine the effects of the littoral food web structure in Massachusetts winter drawdown lakes with emphasis on fish species and life stages that predominantly consume benthic invertebrates. Additionally, we are interested in how winter drawdowns alter seasonal habitat availability (i.e., macrophyte structure and density) for obligate littoral zone fish species. We invite ideas to generate research needs in New England to more completely understand the physicochemical and ecological dynamics of littoral zones in winter drawdown systems.

How zooplankton (or at least, how a certain zooplankton key) may be able to show us the way to increasing appreciation of biodiversity in freshwater systems
Shane Bradt, James Haney, Amanda Murby, University of New Hampshire Cooperative Extension

Biodiversity in freshwater systems is a topic of interest to scientists, managers and educators alike. In most cases, a true assessment of ecological state of a lake or river can be difficult to produce due to lack of resources, knowledge or available expertise. At the NEAEB meeting in 2003, the UNH Center for Freshwater Biology unveiled the first public version of their Key to Zooplankton of the Northeast. The goal of the key was to provide audiences ranging from novices to experts with the inspiration and resources to better appreciate and understand zooplankton diversity in lakes. Our approach strove to remove some of the technical barriers that prevent new users from learning about lake biodiversity, while maintaining the scientific accuracy needed by professionals. Over the past 11 years, the zooplankton key has been expanded, updated, and has morphed into much more than a taxonomic key. A similar approach to taxonomic education has been recently rolled out to additional groups of

organisms, including phytoplankton, stream insects and vernal pool communities. Through this process, we have learned (and unlearned) a great deal about how to educate a range of users about taxonomy of freshwater organisms and how traditional taxomomic keys relate to the modern world of interactive media. Come find out how zooplankton may show us the way to increased appreciation of freshwater biodiversity.

Making sense of bioassessments of multiple taxonomic groups
Tom Danielson, Maine Department of Environmental Protection

Many states have or are developing bioassessment methods for more than one taxonomic group. For example, Maine DEP uses both macroinvertebrate and algal models to determine if streams and rivers attain biological criteria. When both models have the same assessment result, then biologists can have greater confidence in management decisions. But what happens when the models have different results? What patterns are biologists observing in the response of different assemblages to varied stressors at different spatial and temporal scales? Can conflicting assessment results provide valuable information for diagnosing stressors impacting streams and rivers? How do conflicting assessment results effect attainment decisions for the Integrated 305b/303d Report? Another aspect of bioassessments is characterizing reference conditions by monitoring minimally disturbed sites. Can a waterbody provide reference conditions for one taxonomic group but not another? The discussion about these questions is open to anyone with an interest in bioassessments of streams, lakes, wetlands, or marine waters.

Identifying characteristics of selected fish and aquatic invertebrates poised to invade New England
Mark Malchoff, Lake Champlain Sea Grant

Approximately 20 species of invasive mollusks, fish and crustaceans are currently impacting or threaten to impact Northeast U.S. freshwater aquatic ecosystems. An overview of the major species in these groups (with a New York and Champlain basin bias) will be provided. Identifying characteristics will be presented for about 20 species, along with habitat, range, spread mechanisms and ecological impact information. Notable example organisms from the group include Asian clam (*Corbicula fluminea*), tench (*Tinca tinca*), spiny waterflea (*Bythotrephes longimanus*) and bloody-red shrimp (*Hemimysis anomala*). Recent range expansions of these example species (and implications of these range expansions for New England waters) will be discussed.

Recommendations on the Utility of Boat Inspection and Decontamination as Components of an Integrated Aquatic Invasive Species Prevention Strategy in the Adirondack Region
Eric Holmlund, Paul Smith's College, Meg Modley, Lake Champlain Basin Program, and Meghan Johnstone, Adirondack Park Invasive Plant Program

For close to two decades, organizations and communities in the Adirondack region have worked together to address aquatic invasive species (AIS) through coordination, prevention, detection, and management initiatives. Prevention efforts promoting clean recreation practices are underway and include education via brochures, signage, presentations, news releases etc.; inspections by volunteer and paid boat launch stewards; local laws prohibiting the transport of aquatic species; and boat washing, that is, decontamination. An increasing emphasis on inspection and decontamination among lake communities and state environmental resource management agencies highlights the need for clarifying the role of inspection and decontamination in a regionally coordinated, landscape-level AIS spread prevention program. This report summarizes the available scientific literature regarding

watercraft inspection and decontamination and applies existing datasets to inform recommendations for the Adirondack region. Data from 25,000 boating parties surveyed by four boat launch steward programs in 2012 shows that boaters are traveling from more than 600 destinations, and 35% are not taking any spread prevention measures. Combining key recommendations from the scientific literature with regional datasets, evaluation of regional AIS distribution, and boater use data suggests that at least three overland transport sub-networks, three linkage waterways, and eight invasion spread hubs may exist in the Adirondack region. The report includes three management recommendations: 1) Stewards deployed at priority uninvaded waterways will reduce the risk that they will become invaded. 2) Steward inspections on those AIS plant-infested waterways with trailered boat access points will help to limit the landscape level spread of aquatic invasive plants. 3) Steward inspections and decontamination stations at 13 high-priority waterways will help to limit the spread of aquatic invasive animals and also limit the spread of new AIS introductions to the region. Of those 13 waterways, seven have aquatic invasive animals, four serve as invasion spread hubs, and two serve as linkage waterways. Various levels of coverage also are presented for consideration based on risk reduction and resource availability.

Characteristics of Cyanobacteria that Make Monitoring Their Populations and Toxicity Challenging
Joan Beskenis, Massachusetts Department of Environmental Protection, Division of Watershed Management

Cyanobacteria can produce several different toxins including hepatotoxins (microcystins) by Microcystis, Anabaena, Planktothrix, neurotoxins (anatoxins) by Anabaena, Oscillatoria, Aphanizomenon, and lyngbyatoxins and other dermatotoxins (skin irritants) by Lyngbya, Aphanizomenon,Cylindrospermopsis. This is a partial list of the genera that may produce toxins. May is the critical word since the ability to produce toxins has a genetic component as well as environmental triggers. A strain of a toxic species may be able to produce toxins, but it is 'turned off' awaiting yet still poorly defined triggers that may turn the toxicity back on. Toxic strains cannot be determined visually, instead molecular techniques like polymerase chain reaction (PCR) tests can be used. In Massachusetts, as well as many other states and countries, the risk of illness from cyanobacterial blooms in recreational waters and often in drinking water is determined by conducting cell counts of the cyanobacteria, identifying potentially toxic genera and then using a test kit to determine if microcystin is present. In Massachusetts, we have confirmed many cyanobacterial blooms in our waterbodies by cell counts. Toxicity data is scarce but elevated microcystin levels in lake samples have not typically correlated with high cell counts. It is not known if the genes for toxicity production are present or if some environmental factor is keeping them turned off. Sampling has primarily been conducted in the eastern part of the state during the summer months, leaving questions remaining of spatial and temporal factors affecting growth and toxin production. Besides the problems associated with determining the risks that a cyanobacterial bloom presents to people and pets, the sampling of cyanobacteria and interpretion of the results can be challenging because of the unique characteristics cyanobacteria display. Many cyanobacteria are buoyant, a by-product of the gas vesicles they produce. In this buoyant state under calm conditions they may gather at the surface where they can be pushed by the prevailing winds into coves and leeward shores. Their cell counts and potentially toxin levels can be elevated due to this vagary of weather. Later, wind shifts may reduce cell counts and toxicity risks at one site but perhaps increasing them at another. Buoyancy can also be weakened by changes in stored photosynthates and development of nutrient limitation. Visible changes may occur including the loss of surface scum overnight, but then having it re-appear later in the day.

Volunteer monitoring of cyanobacteria on Lake Champlain
Mike Winslow, Lake Champlain Committee

Cyanobacteria blooms are a subject of concern on Lake Champlain, as they have the capability of producing toxins that may present a danger to recreational lake users and those who draw their drinking water from the lake. We developed a network of volunteers around the lake to monitor for the presence of cyanobacteria blooms throughout the season. From 2003 through 2011 volunteers collected whole-water samples which were later analyzed for cyanobacteria and cyanobacteria toxins. In 2012 and 2013 we shifted to a visual assessment program which allowed us to expand the scope of monitoring at a lower cost. For the visual assessment program we provided training to assist lay people in identifying and assessing the risk of cyanobacteria blooms, held training sessions throughout the region, and collected reports during the summer months. Monitors classified water conditions as having little or no cyanobacteria present, cyanobacteria present at less than bloom levels, or cyanobacteria bloom present. For the twelve week monitoring season of June 15 to September 6, 2013 we received a total of 675 reports. Of these 557 came from 54 locations that reported more than six times, 93 were 'supplemental' reports, and 25 came in after the end of the regular monitoring season. The vast majority of reports (94.1%) indicated no algae blooms present. Of the remaining reports 4.0% indicated low level blooms and 1.9% indicated extensive blooms. Volunteer monitors' reports were used to guide public health decisions about when to close beaches and were used to populate the Vermont Department of Health's status maps of cyanobacteria conditions on the lake.

The NRCS Initiative to Improve Water Quality by Promoting Soil Health
Fletcher Potter, USDA/NRCS

The quality of surface waters in Vermont is largely controlled by the the quality of water running off and through the landscape. Agriculture is a large part of that landscape in Vermont. Increasing soil health on farms is an effective method for improving the quality of waters flowing over and through these agricultural areas. Increased soil health increases infiltration rates, reduces soil erosion and the loss of nutrients in surface runoff. Good soil health also builds aggregate stability, increases organic matter content and nutrient adsorption. This decrease in erosion, the decrease required nutrient inputs and decreases in of nutrient losses can effectively improve the quality of our surface waters. USDA-NRCS is now promoting soil health as a national campaign. A number of financially supported practices are available that can improve soil health on Vermont farms.

Minimizing Flood Risks and Habitat Impacts Due to Post-Flood Recovery Efforts
Roy Schiff, Milone and MacBroom

Large floods alter the physical and biological condition of streams. Excessive erosion and sediment deposition impact habitat over large spatial scales in a short period of time. Common practices associated with flood recovery such as channel excavation, bank armoring, and reconstruction of public infrastructure and private property further impact habitat often leaving channels smooth, homogenous, and fixed in place. The resulting channels are often confined and isolated from floodplains. The best way to avoid habitat impacts due to post-flood recovery efforts is to minimize damages and the need for channel management. Floodplain protection and restoration is one approach to minimizing the need for channel work where river channels have room to move in the landscape, and sediments deposited during large floods, which might otherwise aggrade channels and raise flood elevations, can be captured, stored or, if necessary, removed from the floodplain with minimal impact to instream aquatic habitat or flood risk. Conserving a river corridor to provide space for the river to migrate reduces future

flood risks. Adequate space for the river to move often prevents vertical bed instability and the need for invasive flood recovery practices. Managing channels towards a least erosive, vertically stable condition is feasible during flood recovery with some improvements to typical flood recovery methods. Furthermore, an opportunity exists to efficiently attain objectives such as public safety, hazard mitigation, and fish and wildlife protection due to the work taking place at larger scales of the river corridor than typical river management projects. If performed correctly, flood recovery projects can move the river toward a more stable equilibrium condition reducing the economic and environmental costs of channel management over the long term. Restoration of channel and floodplain geometry to minimize unnatural down-cutting or sedimentation is beneficial to people and habitat in the long run - reducing channel management costs and creating a physical foundation for the processes that create and maintain river habitat. In the wake of Tropical Storm Irene, Vermont struggled to move beyond traditional means of flood recovery to protect transportation infrastructure and avoid exacerbating flood risk and damaging aquatic habitat. In the aftermath of Irene, an approach to flood recovery is emerging that is based on management activities guided by fluvial geomorphology, practices such as floodplain restoration, and river corridor protection.

Threading the Needle: Vermont's Stormwater Management Manual
Amy Macrellis, Stone Environmental, Inc.

Since Vermont's first Stormwater Management Manual (VSMM) was published in April 2002, substantial advances in the range of stormwater treatment practices and site design approaches have been made nationally. Development and re-development strategies that attempt to work with nature, and built stormwater practices that mimic hydrologic processes, are becoming more widely accepted and implemented. State-level and local stormwater regulations and guidance manuals are also shifting-sometimes to take these new strategies into account, and other times to drive a fundamental change in how practices to mitigate stormwater-related impacts from the developed landscape are planned for, constructed, and maintained. In the fall of 2013, the Vermont Dept. of Environmental Conservation's Stormwater Program began working with a diverse stakeholder group and a multi-disciplinary consulting team to update its stormwater manual. The Stormwater Program issues permits that govern how runoff from impervious surfaces is managed after development/redevelopment projects are complete for projects that meet permitting thresholds - about 300 permits per year since 2010. This manual update has the potential to create and apply a framework that explicitly acknowledges the hydrologic difference between forest and turf, and disturbed and undisturbed soils, and thus could create better incentives to conserve forests, reduce mass grading, restore soils, and reforest sites. As we've been working with the stakeholder group to identify approaches that might be applicable to Vermont, we've found examples of states (such as Maryland and New York) with good programs and strong standards-but also with permitting and accounting processes that are administratively complex, time-consuming for practitioners and regulators, and difficult to administer. Our desire to thread the needle-to find or create strong standards and a process that incentivizes applicants to meet these goals WITHOUT extensive accounting requirements or design "do-loops" - is at the heart of "why is it up to little old Vermont to re-invent the stormwater wheel". This short presentation will frame the issues and our progress to date, and invite discussion in three areas: ·The manual's draft framework and standards; · How non-structural and structural stormwater treatment practices are credited within the framework; and · How the forthcoming manual as currently envisioned fits (or doesn't fit) with big-picture water quality challenges like the Lake Champlain phosphorus Total Maximum Daily Load.

Turning water monitoring data into improvement - Vermont's Tactical Basin Planning Process
Neil Kamman, Vermont Department of Environmental Conservation

Having since 1970 collected over one million lines of water quality data and documented 3.4 million macroinvertebrate enumerations, the little State of Vermont sits upon a green mountain of data. While that might seem like an achievement in and of itself, the public investment underlying such a collection requires that these data continually be put to the best and highest use. Recognizing this, and following principles of modern integrated watershed management, the Watershed Management Division of VTDEC has developed a comprehensive Surface Water Management Strategy, and associated tactical watershed-based implementation process, to protect and restore surface waters. These tools rely upon our constantly renewing data and assessment archive to drive a transparent, predictable, and rational approach to on-the-ground BMP deployment. Geographically explicit BMP and protection opportunities are identified in Tactical Basin Plans, the implementation tables of which direct the disbursement of up to $2.5M in nonpoint source remediation funds per year, using State of Vermont general funds. The Tactical Planning Process is the State of Vermont's solution to implementation planning for the critical, yet daunting Lake Champlain Phosphorus TMDL, and all other large and small watershed remediation and protection projects.

Session: Developing Biocriteria 1-D1
Thursday 3/27/14 3:30 – 5:00

Biological Criteria Development for Maine Wetlands
Jeanne L. DiFranco, Beth Connors, Thomas J. Danielson, Ph.D. and Leonidas Tsomides, Maine Department of Environmental Protection

The Maine DEP Biological Monitoring Program is developing wetland indicators and biological criteria for multiple taxonomic assemblages. We completed a provisional statistical model for aquatic macroinvertebrates to inform attainment decisions based on Maine's narrative aquatic life use criteria. Once implemented in rules, the model will serve as the basis for wetland-specific numeric biocriteria. We also developed taxa tolerance values and community tolerance indices for Maine wetland algae, and are working on a wetland algal model to predict aquatic life use attainment. In addition, we plan to incorporate biological indicators for wetland plant communities into our assessment protocols. As a first step, upgrades to DEP's water quality monitoring database are in progress to enable uploading vegetation data including taxa names, Coefficients of Conservatism (CoCs), national wetland indicator status and related data. Biomonitoring Program biologists are also participating in regional initiatives to develop floristic quality assessment (FQA) methods and compile a New England plant database. Currently, the Biomonitoring Program monitors emergent and aquatic bed wetland habitats including depressional marshes, riverine and lacustrine fringe wetlands, and shallow vegetated zones of lakes, ponds and low-gradient streams. The vast majority of monitored wetlands are contiguous with other water bodies, often comprising a significant portion of the watershed, but were previously not assessed because methods developed for rivers, streams and lakes are generally not appropriate for wetland habitats. Development of indicators and biological criteria for several different taxa groups including macroinvertebrates, algae and plant communities will enable us to assess additional wetland types such as forested wetlands, and begin to fill substantial existing gaps in our knowledge about the condition of the State's wetlands and their ecological connections with other aquatic resources.

Lake Assessment and Macroinvertebrate IBI Development in Illinois
Ben Jessup and Jen Stamp, Tetra Tech, Inc.

The Illinois Environmental Protection Agency collected landscape information, physical habitat data and biological samples in 106 lakes throughout the state. In an effort to develop assessment tools, Tetra Tech assisted in compiling GIS data in the catchments of the lakes, definition of reference criteria, establishment of lake classes, and calibration of a multimetric macroinvertebrate index of lake disturbance. The landscape information from the GIS was the basis for defining reference sites, where intensive and proximate land uses indicated potential stress on the lake ecology. Habitat information was considered also, but because the habitat information was not available for all lakes, it was not used as reference site criteria. Instead, habitat indices were compared to benthic macroinvertebrate metrics to find responsiveness to the habitat quality gradient. Benthic macroinvertebrates were collected from 3 sites within each of five habitat types in each lake, providing composite samples for littoral fine substrates, littoral hard substrates, littoral macrophytes, sub-littoral zones and profundal zones. Sample metrics were calculated for separate habitat types, all littoral types, and for a grand composite of all types. After accounting for natural differences among lake types, metrics were compared among reference and non-reference lakes and along the habitat quality gradient to find those that were dependably responsive to stressors. Metrics that were responsive, diverse, and ecologically meaningful were combined into an assessment index. Note: This abstract was written in anticipation of results that have not yet been proven because the work is not yet complete.

Development of a Fish-Based Index of Biotic Integrity for Lakes in Minnesota
Jacquelyn Bacigalupi

In the late 1990's, Minnesota Fisheries researchers developed a fish-based index of biotic integrity (IBI) for a set of small Central-Minnesota lakes having similar geophysical and chemical features. In recent years, an effort has been underway to expand the fish-based IBI tool to additional sizes and types of lakes across the entire state. The focus behind recent work has been to develop a tool to guide Clean Water planning, restoration, and protection efforts and complement pollutant-based water quality sampling efforts on lakes. For tool development, Minnesota's lakes were partitioned into distinct groups, and a unique IBI was developed for each. We have developed four draft IBIs for lakes 100 - 10,000 acres within most areas of the state. Fish data were collected by means of trap nets, gill nets, shoreline seines, and backpack electrofishing. In lakes in the far northeastern part of the state, small mesh trapnets are substituted for seines due to the rocky, steep shorelines. The IBIs are composed of metrics of three types: species richness, community assemblage, and trophic composition. In contrast to lotic IBIs, where a single sampling gear is usually used, data from all four sampling gears were necessary for IBI development. We selected metrics based on responses to measures of human-induced stress based on watershed land use patterns, nutrient loading, and nearshore vegetation quality. For most of the groups, species richness and community composition metrics describing intolerant or habitat specialist species were most sensitive to differences in human-induced stress. Because these species were found in the nearshore zone of lakes, effective sampling of the nearshore fish community was essential to the development and performance of the IBI. Trap-net- and gill-net-based metrics, however, were essential to the development of trophic composition metrics, the trap nets providing the best insectivore and omnivore metric and the gill nets providing the best top carnivore metrics. Work is continuing in lake groups located in the far northeastern portion of the state, characterized by soft water and naturally depauperate in species. This area of the state also has remarkably low watershed and shoreland disturbance. We have also recently started sampling with vertical gillnets in deep cold-water lakes to target the pelagic cold-water fish community, which are particularly sensitive to changes

in water quality, and we are looking at possible associated metrics. We anticipate having four IBI tools, with ecological thresholds, developed by late 2015 for most lake classes in Minnesota.

Session: Land Use & Land Cover -E1
Thursday 3/27/14 3:30 – 5:00

The ability of streams to withstand the effects of urbanization
Tom Danielson, Leon Tsomides and Doug Suitor, Maine Department of Environmental Protection

The Biological Monitoring Program completed its study of the effects of impervious cover (IC) in watersheds on Maine's stream algae and macroinvertebrates. The risk of not attaining Class AA/A biological criteria increases in the range of 1-3% IC. Between 3-6% IC, there is an increased risk of not attaining Class B biological criteria. Finally, there is an increased risk of not attaining Class C biological criteria in the range of 10-15% IC. Location of IC in a watershed matters. In general, watersheds with development close to the streams had poorer quality macroinvertebrate communities than streams with intact riparian corridors. Although IC is commonly used as a surrogate for urban development, IC is only one of many factors that influence urban stream condition. In addition to IC, stream quality is determined by the condition of riparian corridors, flood plains, in-stream habitat, stream bank stability, water flow, water temperature, habitat fragmentation or isolation, specific conductance, nutrient enrichment, and toxic chemicals. IC can influence many of the factors listed above, but natural conditions and non-IC stressors also influence the factors listed above and ultimately determine how resilient a stream is to IC. A stream may be more resilient if the other factors are favorable to healthy aquatic communities. In contrast, some streams may be more susceptible to IC if the other factors are not favorable to healthy aquatic communities. In general, resource managers should be cautious about focusing watershed protection and restoration plans only on IC.

The Conundrum: Aquatic Life Use Support and the Urban Watershed
Rosemary Gatter-Evarts, Connecticut Department of Energy and Environmental Protection

Urban watersheds are subjected to numerous and obvious stressors. What are the options available for meeting water quality goals of fishable, swimmable and aquatic life? What is the highest use for the watershed and what are the realistic options for attaining it and ultimately is it possible to write a TMDL for Aquatic life use?

Landscape and watershed predictors of insect and fish assemblage in Massachusetts streams
Robert Smith, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst and Allison Roy, U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst

Macroinvertebrate and fish assemblages typically reflect in-stream environmental conditions and are widely used for assessing stream health. Both assemblages may disperse between stream reaches and basins and thus may respond to environmental conditions across the landscape in addition to the stream reach. Differences in fish and insect dispersal abilities cause each assemblage to interact with different parts of the landscape. Fish are constrained to swimming through stream channels and insects can disperse through upland areas by flight. Even though dispersal is important for population persistence, relevant measures of landscape characteristics that may control dispersal (e.g., land cover in a radius around a reach, amount of connected stream reaches, etc.) are poorly developed and rarely included in investigations of stream assemblage response to human influence. Our objective was to

determine how watershed land-use and landscape characteristics affect insect and fish assemblages in Massachusetts. In addition to watershed land cover, we compared measures of landscape land cover and stream network configuration to fish and insect assemblage richness, diversity, and composition generated from Massachusetts biomonitoring datasets. Using a model selection framework, we found that watershed land cover and landscape characteristics combined had a stronger effect on fish and insect assemblages than either one individually. When examining the effect of watershed land cover and landscape characteristics individually, we found that watershed land cover had a stronger effect on both fish and insect assemblages than landscape characteristics. Additionally, we compared the effect of land-cover and network configurations "constrained" to pathways through the stream corridor (i.e., the areas fish are confined to) and measures in a radius around sites "unconstrained" by the stream corridor (i.e., areas accessible to insects) on each assemblage. We found that characteristics of the landscape constrained to the stream corridor had a stronger effect on the fish assemblage than unconstrained characteristics, but the opposite pattern was true for insects. These results suggest that assessing characteristics of the landscape could improve assessments of stream health using watershed land cover.

Section: Flow Hydrology-F1
Thursday 3/27/14 3:30 – 5:00

Understanding CWA Section 316(b) and Positive Impacts to Fish Populations
Nathan Henderson, Stantec

Over 500 existing power generating and manufacturing facilities in the US are anticipated to be non-compliant with the new Section 316(b) rules of the Clean Water Act. This will require these facilities to assess current water withdrawal scenarios and investigate the feasibility of installing new intake technologies and/or operational modes to meet regulatory objectives. In some case the financial burden of the new standards may force decommissioning or conversion to alternative fuel sources. For others, it is critical that facility owners assess and understand the costs of possible engineering retrofits at the intake structure, modified operation, and associated aquatic resources monitoring that would accompany the new standards and required compliance schedules. It is expected however, that this rule will radically improve impingement and entrainment rates and ultimately decrease the total number of fish killed or injured each year. We looked at several fossil plants and assessed the relative impingement and entrainment impacts to determine how fish communities may ultimately benefit from these protection standards.

Power Plant, Lower Charles River, MA: Impacts, Litigation, Resolution
Gerald Szal, MassDEP and John Nagle, USEPA, Region 1

In 1999 the Mirant Kendall Power plant, located along the Lower Charles River Basin in Cambridge, MA, was operating only during "peak" hours of electrical demand each day, utilizing only a portion of its 80 mgd discharge limit for once-through cooling water. In the early 2000's the facility decided run at peak power making full use of its discharge limit. The increase in power generation resulted in an intake and discharge that was 6-7 times the 7Q10 of the Lower Charles River. Both intake and discharge had a great capacity to impact migratory and resident fish populations especially due to peculiarities of the Lower Charles basin. This talk is a review of some of the facility's impacts, the generation of restrictive permit limits, the federal appeal that followed, and a surprising solution that resulted in a 95% reduction in intake and discharge but continued operations at the facility.

Hydrological impacts of water supply reservoirs in Massachusetts streams
Todd Richards, Massachusetts Division of Fish and Wildlife, Christopher R. Smith, University of Massachusetts Amherst and Allison H. Roy, U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst

Stream ecosystems are impacted by a variety of human uses, particularly in the densely populated northeastern United States. Surface water supply systems are designed to capture and divert a portion of runoff from the surrounding landscape, providing a critical public water supply resource, but also resulting in numerous potential impacts to upstream and downstream ecosystems. The extent to which this diversion alters streamflow magnitude, frequency, timing, duration, and rate of change has not been adequately studied. In Massachusetts, modeled stream flow estimates have been developed for unaltered conditions through the use of the US Geological Survey's (USGS) Sustainable Yield Estimator, and estimates of reservoir discharge (regulated stream flow) is available for 38 water supply systems through the USGS Firm Yield Estimator. These estimators provide the unique opportunity to compare altered and unaltered stream flow estimates for streams below surface water supply reservoirs. We calculated 32 ecologically-relevant stream flow parameters using Indicators of Hydrologic Alteration software. Reservoirs modeled to be operating at their Firm Yield consistently failed to discharge any water to downstream resources, resulting in greatly reduced flow magnitudes and longer duration low flows compared to unmanaged conditions, but the extent of alteration is dependent on several variables. We explored relationships with natural watershed characteristics and water supply characteristics to try to explain the differences across sites. Understanding the relationship between surface water supply characteristics and downstream flows can inform future water allocation decisions.

Session: Water Quality Monitoring-G1
Friday 3/28/14 8:00 – 10:00

Ten Years of Data Collection at Candlewood Lake, CT by Students from 5 Secondary Schools
Alberto Mimo, Education Connection and Larry Marcician, Candlewood Lake Authority

Project CLEAR (Candlewood Lake Environmental Awareness and Responsibility) has been training 125 students for each of the last ten years to collect a wealth of lake-related data from throughout the 5,200-acre lake. Each year the large group is broken into eight research teams who are led by high school teachers who have received ecological training in advance to work with students one week at the end of June to collect data for the Candlewood Lake Authority, The CT Department of Energy and Environmental Protection, the University of Connecticut, the Connecticut Agricultural Experimental Station and several other agencies. Student complete water quality tests, collect insects, plankton and periphyton samples from local streams and from the lake itself, dive in the lake to complete an assessment of invasive plant management by mapping the lake floor and inventorying invasive species, and complete inventories of the forest land around the lake. The collected data is distributed to local researchers to help with their assessment and management of the lake. All eight projects are completed with corresponding QAQC and QAPP documentation.

Pre- and post-TMDL Monitoring on the Assabet River: Water Quality and Aquatic Plant Biomass Trends 1993 - 2013 (or The Value of Long-Term Fixed-Station Monitoring)
Suzanne Flint, OARS

Longitudinal trends in total phosphorus, nitrates, and dissolved oxygen at fixed stations are examined in relation to upgrades to four municipal wastewater treatment plants on the Assabet River. In 2004 the MA DEP issued a Total Phosphorus TMDL for the Assabet River proposing an adaptive management strategy for remediating phosphorus loads on the Assabet, the first phase of which included reducing summer wastewater treatment plant discharges to 0.1 mg/L TP. Upgrades to the four municipal wastewater treatment plants were completed in the spring of 2012 for an estimated $89M (about half of which was spent for improvements in phosphorus removal). OARS' (formerly the Organization for the Assabet River) water quality data shows significant decreases in total phosphorus, improved dissolved oxygen concentrations, but increased nitrates, over the period of record (1993 to 2013). Water quality and aquatic plant biomass data are compared with the modeling predictions for the river and water quality standards under the Clean Water Act. The effects of water quality changes on eutrophication in the impounded areas of the river are also discussed.

Restoring Water Quality in the Lake Memphremagog Basin, Quebec/Vermont
Fritz Gerhardt, Beck Pond LCC

Over the past decade, there has been increasing concern about water quality conditions in Lake Memphremagog, especially the high phosphorus and turbidity levels and more frequent and widespread algal and cyanobacterial blooms. Because most of the lake's watershed lies in Vermont, considerable effort has been undertaken to identify and remediate nutrient and sediment sources along the Vermont tributaries of the lake. During 2005-2013, we undertook a multi-part project to identify and assess nutrient and sediment sources along the Vermont tributaries in order to identify, develop, and implement phosphorus-reduction projects to protect and restore water quality in Lake Memphremagog. First, we measured total phosphorus, total nitrogen, and turbidity at 134 sites to pinpoint and assess potential nutrient and sediment sources along the Vermont tributaries of Lake Memphremagog. Second, we conducted spatial and statistical analyses of these water quality data to identify and prioritize subwatersheds that likely exported the greatest amounts of phosphorus into the lake. Within these priority subwatersheds, we partnered with staff from other environmental and agricultural agencies to identify, prioritize, and implement phosphorus-reduction projects and practices. Finally, we used these water quality data to evaluate the success of previously-implemented phosphorus-reduction projects. Collectively, these data and analyses greatly increased our understanding of water quality problems and allowed us to identify, implement, and evaluate protection and restoration projects to reduce nutrient and sediment inputs into the Vermont tributaries of Lake Memphremagog.

Merging water quality standards and monitoring and assessment produces better management outcomes
Chris Yoder, Midwest Biodiversity Institute

A central concept in the effort to improve the rigor of State biological assessment programs has been the integration of water quality standards and monitoring and assessment as a critical supporting framework for water quality management. Specifically this includes enhancing the descriptions of aquatic life designated uses and their measurement via numerical biological criteria and biological assessment. Known as the "TALU"? approach it includes tiered aquatic life uses (TALUs) based on numeric biological criteria and implementation via an adequate monitoring and assessment program

that includes biological, chemical, and physical measures, parameters, indicators and a process for stressor identification. States that have developed the level of detail needed to have a linkage between their WQS and their monitoring and assessment programs have been successful in achieving water quality management outcomes that would not have occurred under a framework of general uses and monitoring for statewide condition. Essential components of this more developed framework include: 1) tiered aquatic life uses that are defined in accordance with how the numeric biocriteria for each have been developed, 2) a monitoring program that has sufficient spatial resolution to reveal degrees of quality along pollution continuums in rivers and streams and at the same scale at which management and regulatory programs are being applied, and 3) language in the WQS that specifically describes agency responses to impairment and attainment of tiered use biocriteria as revealed by a watershed level monitoring program. Two recent court decisions concerning the imposition of NPDES effluent limits in Ohio specifically point out the utility of the TALU framework. These results point up not only the utility of merging WQS and monitoring and assessment, but also legally defines the level of and types of data that are sufficient to implement such an approach by modernizing state WQS. Attaining the level of rigor to implement such an approach is consistent with the U.S. EPA guidelines specified in Biological Assessment Program review: Assessing Level of Technical Rigor to Support Water Quality Management (February 2013).

Session: Water Quality Monitoring 2- G2
Friday 3/28/14 10:30 – 12:00

Watershed Based Water Quality Monitoring Experimental Design and Implementation for Large Scale Wind Projects
Josh Sky, VHB

This presentation provides guidance for designing water quality monitoring projects for large scale wind projects in conjunction with the protection of designated uses of receiving waters and in accordance with the requirements of the Vermont Water Quality Standards. Suitable locations for wind development projects in Vermont tend to be located relatively remote high elevation ridgeline areas. The potential development of high elevation or ridgeline projects, with multiple receiving waters spread over a potentially large area, presents a challenge for a cost effective but comprehensive stream based water quality monitoring program. Effective monitoring relies on the careful review and selection of stream monitoring locations that isolate the project, and also are sited far enough down from the ridgeline such that perennial flows, compatible with maintaining aquatic biota populations, are present. For many remote areas and small streams in Vermont, documentation of aquatic biota and other water quality data is limited and monitoring begins with the development of a benchmark program to be used as a basis for comparison of pre- and post-development conditions. The benchmark study is then used as the blueprint for experimental design including monitoring parameters and frequency of sampling in order to assess the response of the streams during and following project construction.
Part I of the presentation will review the design and implementation of water quality monitoring programs implemented at two large scale wind projects located in Sheffield and Lowell, Vermont. Topics covered in Part I will include regulatory compliance, monitoring site selection, monitoring parameters, and benchmark data collection. Part II is a summary of monitoring results collected to date at each site - which are generally grouped into five categories: physical and chemical constituents, temperature, substrate, channel characteristics, and aquatic organisms.

High Frequency Turbidity Monitoring to Quantify Sediment Loading in the Mad River
Scott Hamshaw, Kristen Underwood, Donna Rizzo, University of Vermont

Excessive sediment loading of river systems is an indicator of a number of stressors to surface waters including channel erosion, encroachment, and land erosion. In river systems subject to stressors that cause disequilibrium, excessive sedimentation and deposition can negatively affect aquatic habitat. In addition, nutrients and organic matter associated with eroded sediments are a major source of impairment to surface waters including Lake Champlain. Accurately measuring sediment load can be important for monitoring the effects of climate change and river management strategies. Typical sediment monitoring comprises periodic sampling during storm events and is often limited to gauged streams with flow data. Continuous turbidity monitoring enhances our understanding of river dynamics by offering high-resolution, temporal measurements to better quantify the total sediment loading occurring during and between storm events. In this study the first distributed network of continuous turbidity sensors was deployed in Vermont in the Mad River Watershed, located in Central Vermont. Periodic water quality sampling during storm events enabled turbidity versus total suspended solids relationships to be established. The Mad River and five tributaries were selected as a test bed because seven years of periodic turbidity sampling data are available and it represents a range of watershed characteristics. In sub-watersheds with monitored turbidity, stage, 15-minute precipitation, soil moisture and air and water temperature data were also collected. Total sediment loading was computed using the turbidity and discharge data for the Mad River and the five tributaries. During the 6-month period from April 2013 to October 2013, over 20,000 tonnes (or 55 tonnes/km2 of drainage area) of suspended sediment was discharged pass the USGS gauging site on the Mad River. Utilizing the additional meteorological data, sediment loading on a per storm basis was also calculated. A probabilistic estimate of the sediment load associated with a given rainfall event is then calculated and used with future climate scenarios to stochastic simulation of sediment loading. With reliable estimates of suspended sediment discharged from the tributaries and the main stem of the Mad River a more robust foundation for building a sediment budget can be obtained. In addition, results of this study will assist managers in prioritizing mitigation projects to reduce impacts of sediment loading.

Continuous, real-time streamflow and water-quality monitoring in the Blackstone River at the Massachusetts-Rhode Island state line
Jason Sorenson and Kirk Smith, USGS New England Water Science Center, and Elaine Hartman MA Department of Environmental Protection

The Blackstone River, which drains 39 municipalities in Massachusetts and Rhode Island before discharging into Narragansett Bay, has a long history of industrial contamination and cultural eutrophication. The U.S. Geological Survey, working in cooperation with the Massachusetts Dept. of Environmental Protection, recently completed a three-year study of water quality at multiple stations on the Blackstone River mainstem and several of its tributaries. The study was designed in part to assess the potential for natural attenuation of nitrogen loading in the river. One mainstem station, originally established approximately 1.2 miles upstream from the Massachusetts-Rhode Island state line, has been reactivated and configured for continuous monitoring of river stage, precipitation, water and air temperature, specific conductance, turbidity and phytoplankton-chlorophyll concentration. Streamflow is monitored at a nearby site and the data used to determine intervals for flow-proportional composite sampling for analysis of total nitrogen, total phosphorus and dissolved trace-metal concentrations. Representative samples are also collected manually and analyzed for these constituents and several others (dissolved nutrient species, total trace metals, common ions, turbidity, suspended sediment, dissolved organic carbon, chlorophyll and phaeophytin concentrations). The goal of this data-collection

program is to provide reliable estimates of nutrient and trace-metal loads in the Blackstone River at the Massachusetts-Rhode Island state line and to develop the capability for real-time monitoring of many of these constituents via continuously measured surrogate data. To date (January 2014) more than 34 four-day (trace metal) and 14-day (nutrient) composite samples have been collected by the automated system at flows ranging from 100 to 4,165 cfs. Constituent concentrations in samples collected by the automated system differed in general by 16 percent or less from those in manually collected quality-assurance samples. Composite concentrations will be combined with flow data to estimate monthly and annual loads for nutrients and trace metals in the river. Data from manually collected samples will be used to develop relations between constituent concentrations and continuously monitored surrogate indicators. These relations will be used to convert the continuously recorded surrogate data into real-time nutrient and trace-metal loads. As TMDLs for the interstate Blackstone basin are developed and implemented, the state-line monitoring station will provide an uninterrupted record of changes in constituent loading patterns in response to hydrologic conditions and mandated load-reduction efforts.

Session: Emerging science revolutionizing monitoring-H1
Friday 3/28/14 8:00 – 10:00

The inherent optical properties of lake water in relation to limnological features in the pelagic zone
David Kalenak, SYR

Sensor technology designed for marine environments has advanced significantly in recent decades. Key among them is the ability to measure rapidly, with high spectral resolution, the attenuation and absorption coefficients; and at discrete wavelengths, the backscattering coefficient. (All are considered to be inherent optical properties or IOPs). Select IOPs are robust surrogates in relation to total particulate and dissolved organic matter and oceanographers utilize this fact, in combination with modern deployment platforms, to produce near-continuous spatial information on select biogeochemical processes. Much of this technology has yet to make significant inroads in freshwater science. The purpose of this presentation is to introduce an instrument package capable of measuring the abovementioned IOPs and show how the vertical profiles can be used to assess bulk processes in great detail; associated applications are also explored. Specifically, and in the context of physical quantities (e.g., thermal stratification or light penetration), we will look at the concentration of chlorophyll a relative to actual biomass; changes in the particle size index and composition (e.g., organic vs. inorganic); the concentration and compositional aspects of CDOM; and through pigment biomarkers in absorption spectra, identify the dominant phylum in phytoplankton assemblages. In addition, phytoplankton absorption spectra, a refined IOP, is used to demonstrate that algal communities can produce (in the aggregate) unique optical signatures. Measurements from Lake Auburn in Maine and the Finger Lakes in New York will be used to showcase these concepts. (Note: attendees are assumed to have a basic understanding of optical physics.)

Microbial source tracking of E. coli employing ribotyping in the Lamoille River basin, VT
Bob Genter, D. Minkoff, A. Murphy, J. Hokenberg, M. Luther, and E. Harris, Johnson State College

Escherichia coli are commonly found in stream water. High concentrations of *E. coli* have economic consequences due to beach closings and human health concerns. Questions revolve around which warm-blooded animals are the sources of these *E. coli* and whether these sources are related to land use practices. Nineteen stream sites from ten tributaries of the Lamoille River, VT, have been sampled for *E. coli* in mid-June from 2008 to 2013. Genetic barcodes (or fingerprints) of the *E. coli* collected from streams were generated by Ribotyping, which is an automated RFLP analysis that targets the rRNA-

coding region of the bacterial genome. This research is ongoing. We will report on trends in the relative abundance of sources of *E. coli* (Cow, Fisher, Goose, Human, Otter, and *E. coli* associated with multiple sources) as they relate to total catchment size and proportion of forested, impervious, and agricultural land uses.

One algorithm to rule them all? Recent advancements in the use of remote sensing to estimate chlorophyll in New England lakes
Shane Bradt and James Haney, University of New Hampshire Cooperative Extension

New England possesses a population of extremely diverse lakes in spite of its relatively small geographic size. Through efforts of the New England Lakes and Ponds project and research at the University of New Hampshire, a spectral library with paired limnological measurements was developed for lakes in the region. The library is comprised of 90 spectral measurements from 63 lakes representing chlorophyll concentrations from 1 to over 100 ug/l. A wide variety of algorithms for the measurement of water quality were tested, both for on-lake reflectance measurements and simulated satellite bands. Several algorithms yielded RMS errors of < 0.250 (chlorophyll log decades), providing evidence for methods that can be used to accurately estimate chlorophyll in lakes. In addition, the data collected in this study were combined with datasets from the Great Salt Lake (51 spectra), Spanish lakes (179 spectra) and coastal cruises (169) to explore the best approach to using remote sensing to estimate chlorophyll in a wide range of inland and coastal water bodies. A recently publication from this collaborative work has introduced an Optical Water Type model which allows algorithms to be applied based on the spectral characteristics of each measurement (or pixel in an image), not a pre-governed algorithm based on what is considered to be the best fit for waters in a geographic region.

A modified framework for trophic status assessment of large lake ecosystems using existing water quality datasets: Application to Lake Champlain
yaoyang xu, Andrew W. Schroth, and Donna M. Rizzo, EPSCoR, University of Vermont

This study develops a powerful modification to the framework of trophic status assessment for a specific ecosystem, which is illustrated with a comprehensive analysis of long-term water quality dataset from Lake Champlain (1992-2012). We used this system as a case study to revisit and revise the Carlson's TSI equations (1977) that are commonly employed for trophic status assessment in the water quality literature. Our results highlight the necessity to apply this modified approach to individual lake data sets for more accurate trophic status or phosphorous risk assessment. We illustrate an example of the nature of this application through an assessment of the spatial distribution tropic status and phosphorous risk in Lake Champlain. This approach can then be applied to both historical and current datasets with powerful potential management and research application for classification of specific lake ecosystems and subsequent identification of particularly threatened systems.

Session: Developing Biocriteria 2-H2
Friday 3/28/14 10:30 – 12:00

The development and application of a New York State specific fish based index of biotic integrity (IBI)
Anne Burnham Zachary, SUNY College Environmental Science and Forestry

Assessments of biotic integrity have been widely utilized for nearly forty years as a relatively inexpensive and effective method of evaluating the condition of aquatic systems. Karr (1981) developed the original index of biotic integrity (IBI) as a way to assess the general health of streams and to evaluate

environmental change and degradation using fish community data. Today, many studies and biomonitoring programs use only a single method, such as fish or macroinvertebrates, to assess stream quality, despite the different response of aquatic assemblages to environmental changes and perturbations. Evaluating multiple assemblages is necessary to adequately assess stream condition and ecological integrity. Using historical fish community data collected by the New York State Department of Environmental Conservation (NYSDEC), we are developing metrics that aptly represent the changes in fish communities along environmental gradients. In the summer of 2014, we will be collecting fish data from across the state to verify and calibrate the developed metrics. From there, comparisons between the fish IBI and the macroinvertebrate metrics routinely used by the NYSDEC Stream Biomonitoring Unit can be made. Developing a robust fish index of biotic integrity that is specific to New York State will aid government agencies and researchers from not only New York, but the Northeast to evaluate the integrity of streams around the region from a multi-assemblage point of view.

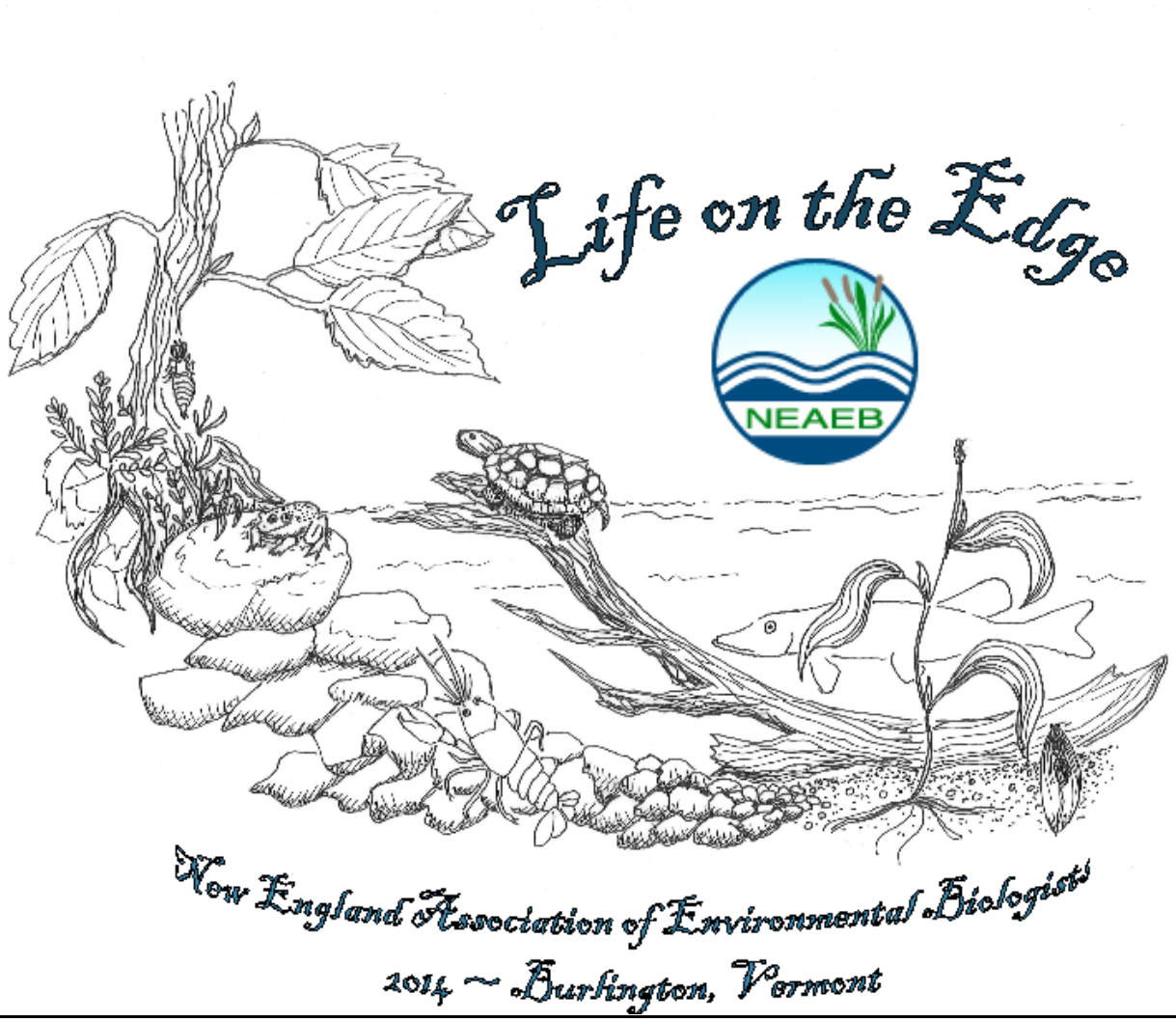
Recognizing the need for and development of biocriteria for small headwater streams in Ohio
Chris Yoder, Midwest Biodiversity Institute

The first IBI types of biological assessment methods of the 1980s focused primarily on wadeable streams. The classic work of Karr and his students offered a suite of commonly understood attributes of fish assemblages for streams that were large enough to have perennial flows. While literally hundreds of fish IBIs have been developed since and for both wadeable and non-wadeable streams and rivers, comparatively fewer efforts have focused on headwater streams where intermittency of flows is a predominant physical factor. We adapted the concept of the original fish IBI to headwater streams in Ohio by developing substitutionary metrics that are responsive to the cadre of factors that are affiliated with small stream size and intermittent flows. Small stream size alone affects fish assemblage richness and therefore the ability of some of the seminal IBI metrics to function. This step was taken first and we followed the metric substitution guidance in Karr's seminal document on IBI development. Because intermittent flows are an important issue for these streams, metrics that were responsive to this condition as both a natural occurrence and as a stressor were also included. This had direct and immediate benefits to the assignment of tiered aquatic life uses in Ohio's headwater streams, which are initially defined as draining <20 square miles. Prior to the adoption of biocriteria, such small streams were simply classified by their critical low flow characteristics, a practice that ignored other factors that determined the potential to support fish assemblages and it essentially resulted in the under-protection many small streams. By having a bioassessment process that could distinguish between attainable levels of biological condition, various pollution control and stream management practices for small streams in Ohio are more accurately attuned to protecting for the highest potential. The classification of small headwaters streams was further developed as this process was implemented via routine monitoring and assessment to include the delineation of Primary Headwater Habitats.

Using the composition of aquatic macrophyte communities to assess ecological integrity
Alison Mikulyuk, Wisconsin Department of Natural Resources

Aquatic macrophytes hold promise as ecological indicators: they are sessile, common, and respond rapidly to varied sources of anthropogenic disturbance. In Wisconsin, we are exploring an approach to lake biotic assessment that employs multivariate analysis in a reference-condition framework to link aquatic plant community composition to anthropogenic disturbance. We outline a 4-step approach that entails 1) Selecting reference lakes, 2) Categorizing reference plant communities, 3) Categorizing impacted systems, and 4) Comparing community structure in reduced-dimension ecological space. We

applied this method to 266 aquatic macrophyte communities surveyed from 2005-2012. We briefly discuss the benefits and drawbacks to using this approach as an alternative to multi-metric index and suggest that the two analytical methods may be most effective when used together. In summary, we present a technique that reflects impairment due to known sources of anthropogenic impact but is also sensitive to novel or unmeasured stress. This work will improve our ability to understand anthropogenic impact to freshwater lakes and prepare Wisconsin to add aquatic plants to its list of biotic indicators.



NEIWPCC
New England Interstate Water Pollution Control Commission

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION

Lake Champlain Basin Program